INDEPENDENT TRANSPORT SAFETY REGULATOR

Mitigation measures for tool C - rail infrastructure managers

ITSR

Safe transport for NSW

Mitigation measures for tool C – rail infrastructure managers

Instructions

- This tool links to tool C – Appendix D – SPAD data collection tool C for Infrastructure Managers
- A number of possible mitigation measures are presented below for consideration by the rail infrastructure manager.
- Measures have been grouped according to the contributory factors that they relate to.
- Mitigation measures presented in italic text are more applicable to the rolling stock operator of the train involved in the SPAD.

The mitigation measures presented below are:

Part 1.1 For consideration after every SPAD

Part 2.1 Where factors associated with the design of the route contributed to the SPAD

Part 2.2 Where factors associated with the approach to the SPADed signal contributed to the SPAD

Part 2.3 Where factors associated with the signal itself contributed to the SPAD.

Part 1: General measures

Part 1.1: For consideration after every SPAD

- Investigate the SPAD according to the guidance provided in the SPAD guidance document to identify possible contributory factors.
- Maintain a list of all SPAD traps that are identified on each route and show them on a route hazard map. If there is sufficient evidence, consider adding the SPADed section of track to the list of SPAD traps.
- Consider a signal sighting for the SPADed signal and also consider the signal in rear.

Part 2: Infrastructure factors

Part 2.1: Where factors associated with the design of the route contributed to the SPAD

2.1.1 If the signal in rear of the SPADed signal is always encountered at caution or a Low Speed aspect

- Review signalling arrangements to ensure that the signal in rear is optimised. Permanent caution signals, for example, do not provide drivers with information about the next signal, and can therefore be a SPAD trap.

2.1.2 The signal has a different aspect configuration or signal type relative to previous signals

- Consider driver briefings to increase driver awareness of the interfaces between signalling systems.
- If the signal is offset relative to neighbouring signals, consider realigning it to be consistent with other signals in that section by moving it closer towards or further away from the track.
- Avoid intermixing signal types and configuration as much as possible.

- If intermixing of signal types is unavoidable, then consistency in their application is required. Consider a review of the placement of signs to warn drivers about changes in signal type.
- Consider reviewing relevant Signalling Engineering Standards concerned with signal placement to ensure that they recommend that signals should be consistently placed in terms of horizontal distance from the track.
- Ensure that signals along parallel lines are of the same signal type and configuration.

2.1.3 If the signal height is inconsistent with other signals on the route

- Ideally, signals should be at a consistent height, particularly signals of the same type for example, post signals. Consider changing the height of signals along the route to achieve this consistency providing this does not introduce other risks.

2.1.4 If the spacing between the SPADed signal and its immediate predecessor is inconsistent with the spacing between preceding signals on the line

- Consider repositioning the signals to even out signal spacing - the costs involved must be determined as being justified using as low as reasonably practicable (ALARP) principles.
- Repeaters may provide advance warning, if the costs can be justified.

Part 2.2: Where factors associated with the approach to the SPADed signal contributed to the SPAD

2.2.1 If complex track layout distracted the driver

- Consider removing excess lineside information (for example, signal reminder boards and speed restriction reminders) to simplify the driver's task.
- Consider repositioning of lineside information.
- If this hazard reoccurs at a multi-SPADed signal consider a signal sighting to review the infrastructure in the area.

2.2.2 If the signal is beyond a bridge (or tunnel) which restricts continuous and uninterrupted view of the signal on approach

- Ensure that the minimum reading times are met. Consider increasing minimum reading times as much as practicable. If the minimum reading time is not achievable, consider the use of a repeater or a co-acting signal if costs can be justified.
- If the driver's first sight of the signal is at the tunnel exit, consider relocating the signal to achieve the minimum required reading time.
- Consider use of LED signals.
- Ensure that a signal positioned just outside the tunnel exit can be seen either before entering the tunnel, or from inside the tunnel, such that the required reading time is met.

2.2.3 If the visibility of the signal is restricted by station structures

- Consider moving existing equipment which is creating the problem.
- Consider the siting of advertising hoardings and recommend removal or re-siting where this would be beneficial.
- Consider using LED signals, as these are stronger and have a more directed beam.
- Position station furniture such as ladders, water bowsers and tow trucks, where this does not interfere with signal sighting, even temporarily. Manage breaches rigorously.
- Ensure that station structure hazards are specifically recognised in project risk assessments.

2.2.4 If the signal is obscured by overhead wiring structures

- The best solution is to eliminate or reduce the source of the clutter.
- Consider reducing the height of gantry-hung signals.
- Change catenary stagger or registration arm position on approach to the signal.

- Consider using LED signals, as these are stronger and have a more directed beam.
- Signal sighting committees should consider this hazard when sighting new signals near the brow of a hill.
- If signal is frequently SPADed because drivers cannot see one of the aspects a signal sighting should be triggered. Consider installation of tri colour light signal(s) which are less likely to be obscured.

2.2.5 If the stanchions or vertical posts repeatedly occlude the signal on approach and cause a pulsating illusion

- Consider using LED signals, as these are stronger and have a more directed beam.

2.2.6 If lineside clutter prevents continuous and uninterrupted view of the signal on approach

- Move lineside signage if it obscures the signal consider removing it altogether if it is not useful.
- Remove sources of obstruction as much as possible.
- Consider using LED signals, as these are stronger and have a more directed beam.
- Arrange for regular reviews and maintenance of temporary signage.

2.2.7 If, on a curved approach, the driver mistook a parallel signal as his/her own

- Remove sources of obstruction as much as possible for the signal on the curved approach to increase the likelihood that drivers will recognise the correct signal.
- Consider using LED signals, as these are stronger and have a more directed beam.
- Consider the introduction of line identification plates to support the driver in associating a signal and a line. Check whether these can be provided above or below the aspect rather than to the side, to minimise the risk of confusion.
- Consider the use of repeaters if costs can be justified.

2.2.8 If the signal is on a curved approach which restricts continuous and uninterrupted view of the signal on approach

- Perform a signal sighting.
- Consider the use of spread lenses, fibre optic search lights, or LEDs, on curves to provide a wider viewing angle and longer distance viewing.
- Consider altering signal height to improve visibility.
- If signal is on a left hand curve - consider moving the signal from the left to the right hand side of the track, however unusual signal positioning should be avoided unless there is a significant benefit to signal reading time and there is no risk of associating the signal with another line.
- If signal is on a right hand curve consider moving the signal further to the left of the track.
- Relocate the signal along the track, as long as the risk is not transferred elsewhere.
- Consider the provision of a repeater, if an improvement to signal visibility cannot be achieved by any other means. However, provision of repeaters can be expensive and the risks may not justify the costs involved. Co-acting signals may improve visibility in some locations.
- Consider the introduction of line identifier signals and the suitability of providing these above or below the aspect rather than to the side as this may add to the confusion.

2.2.9 If the signal is viewed against a dark surrounding environment which hid the signal backplate

- Consider organising a Signal Sighting Committee visit to undertake a detailed examination of the potential solutions.
- Consider changing the signal to an LED signal (if incandescent). If this is inappropriate or not feasible, consider a white border. Where a signal is visible at long range and is located against a dark background, signal visibility can be improved by painting the area immediately behind the signal backplate white, for example, on a bridge, in order to draw the driver's eye to the

signal. The white area should be of sufficient size that it does not just appear to be a white border. A large, dark background reduces the contrast between the signal backplate and the immediate background. By painting a large area of the wall immediately behind the signal white, the signal to background contrast is increased and the signal head becomes contrast is increased and the signal head becomes more conspicuous.

- Consider relocating the signal if this does not introduce additional unacceptable risk.
- Ensure that the surrounding environment is accounted for in the signal sighting when introducing new signals or relocating existing signals.
- Consider reviewing relevant Signalling Engineering Standards.

2.2.10 If the signal is viewed against a visually complex surrounding environment which hid the signal aspect

- Consider organising a Signal Sighting Committee visit to undertake a detailed examination of the potential solutions. These include:
- Firstly consider changing the signal to an LED signal (if incandescent).
- If this is inappropriate, consider a larger backplate/background to the signal and ensure that the signal aspect is centred on the backplate/background or consider increasing the signal backplate/background to 150% of current size or larger (use a perforated background to overcome wind resistance issues).
- The strength of the structure of old signals and gantries should be taken into consideration: Consider replacing the whole signal structure if the old structure cannot support a large background.
- If a background cannot be located onto a signal, consider using a free-standing background.
- Signal visibility at long range can be improved by painting the area immediately behind the signal backplate white, for example, on a bridge, in order to draw the driver's eye to the signal. The white area should be of sufficient size that it does not just appear to be a white border. A large, dark background reduces the contrast between the signal backplate and the immediate surroundings.
- If signal cages are present, paint the structure, cages and gantry matt black.
- Ensure that the surrounding environment is accounted for in the signal sighting when introducing new signals or relocating existing signals.
- Consider reviewing relevant signalling engineering standards.

2.2.11 If the signal is significantly less bright than adjacent parallel signals or signals ahead that can be seen on approach

- Consider using LED signals, provided this does not make the signal significantly brighter than the other neighbouring signals.
- Relative strengths of signals may only become apparent for approaches on certain routes, or in particular visibility conditions.
- Consider organising a signal sighting committee visit to undertake a detailed examination of the potential solutions. These may include 'shielding' the predominant aspect ahead, adjusting lens range and/or focus.
- If necessary, refocus the lens, change the lens range and/or ensure an adequate cleaning regime. The lens hood may need to be replaced.
- Review all of the neighbouring signals to ensure consistency in signal brightness.

2.2.12 The number of signals visible differs from number of lines visible to the driver (including sidings)

- Consider organising a Signal Sighting Committee visit to undertake a detailed examination of the potential solutions. These include:
- Consider *shielding* the predominant aspect, adjusting lens range, focus, or providing screens.
- Ensure that the number of visible lines (including sidings) equals the number of visible signals from the point at which the driver is required to identify his or her signal.

- On a curved approach, consider incorporating all the signals (including siding signals) onto the same gantry to help prevent count across errors.
- Consider the use of line identifier signs as an aid to the identification of the correct signal and the suitability of providing these above or below the aspect rather than to the side (as this may add to confusion).
- Consider providing line identification arrows on all position light signals in such locations, so that drivers do not mistake the correct signal or misread the clearance of an adjacent position light signal as applicable to them.

2.2.13 If post mounted signals on adjacent lines are not positioned in parallel on a curved approach, so that they appear to swap position

- Consider the use of line identifier signs and the suitability of providing these above or below the aspect rather than to the side (as this may add to confusion).
- Consider the use of repeaters or countdown markers where costs can be justified.
- This problem should be eliminated by placing signals in parallel during the design phase.

2.2.14 If the signal is obscured by foliage

- Ensure that foliage is cut back far enough from the running rail and for sufficient distance to allow the signal to be sighted from its specified sighting point. Check that this level of cut back is maintained throughout the seasons.
- Ensure that drivers have a clear view across left and right hand curves, if this is required to achieve the reading distance.
- Consider providing countdown markers where the signal has a history of being SPADed, or where drivers talk of difficult braking on final approach.

2.2.15 If the track on approach to the signal is obscured by ground vegetation

- Clear ground vegetation regularly, especially on lines with wheat trains. Check that vegetation remains cut back, throughout the seasons.

2.2.16 If there is a rising gradient between the caution signal and the SPADed signal (that meant the driver needed to increase power after encountering the cautionary aspect)

- In the short term, Signal Reminder Boards may be useful for refocusing driver attention. However, caution should be used so as not to install too many signal reminder aids as this may be distracting and divert the driver's attention from the speed control task.
- If signals must be at points of significant change in gradient:
  - Maximise the signal viewing time
  - Recommend driver awareness briefings
  - Ensure that gradient signs are kept clean and clear of vegetations
  - Ensure that gradient signs are positioned correctly (facing the track in the direction of travel)
  - Consider relocating the signal along the track, as long as the risk is not transferred elsewhere
  - Reposition signals to give a better relationship between caution/danger aspects and geography/gradients
  - Maximise the viewing time or provide repeater or countdown markers for signals beyond a change in gradient if costs can be justified.

2.2.17 If the speed limit increases on the approach to the signal

- Relocate signage if it interferes with the driver's signal reading task.
- Plan speed limit boundaries carefully, considering signal positioning.
- Use speed signs only when absolutely necessary and consolidate them wherever possible.
- Consider providing repeater or countdown markers for signals beyond a change in speed if costs can be justified.

2.2.18 If the signal's visibility is adversely affected by sun glare shining off the signal lens

- Consider using an LED signal as they are brighter may be less affected by sun glare.
- Ensure that signal hoods are correctly fitted.
- Consider extending the hood length and lamp voltage (most signals run below maximum voltage to prolong filament life) to increase brightness.
- Provision of lenses with better hot strips improves 'close-to' sighting.

2.2.19 If a signal-like light was in the driver's field of vision on approach to the signal

- Consider using LED signals, as these are stronger and have a more directed beam.
- Consider screening off non-signal lights from the track so that they cannot distract drivers.
- Consider using a large matt black background to increase the opportunity for the driver to both locate the signal and read the aspect.
- Identify the owner of lighting or clutter and if practicable manage-out the problem: by explaining the significance of the problem, the owner may agree to change, removal or screening of the light source. For instance, seek co-operation from third parties to use down lighter type lights and avoid the use of halogen and high pressure sodium lamps wherever possible.
- If signal cages are present, paint the structure, cages and gantry black and use a free standing backplate.
- Local staff/driver knowledge of emerging problems of this kind should trigger a new Signal Sighting Committee visit. Use of standard solutions for problems of glare/ghost aspects may be helpful in some cases (for example, where light reflections from buildings interfere with signal sighting). Shielding the source of glare may be effective with larger backboards or side screening.
- Reduce linespeed, if absolutely necessary, to give drivers time to identify the correct signal.

2.2.20 If the signal backplate/background (or cage) is too small to be able to easily distinguish the signal from the surrounding environment

- Consider using LED signals, as these are stronger and have a more directed beam.
- If signal cages are present, consider painting the access cages matt black instead of silver grey.
- Increase the area of the black surround of the signal head to ensure that the driver sees a minimum of 300mm of black surround underneath the axis of the lowermost aspect.
- Consider the use of perforated backgrounds to overcome wind resistance issues.
- The strength of the structure of old signals and gantries should be taken into consideration: Consider replacing the whole signal structure if the old structure cannot support a large backplate/background.
- If a background cannot be located onto a signal, consider using a free-standing background behind the signal.
- Ensure that the surrounding environment is accounted for in the signal sighting when introducing new signals or relocating existing signals.
- Consider other possible alterations to the signal surrounding environment.

2.2.21 If unusual routing on a parallel track prompted read across to a more familiar (regularly encountered) signal

- Consider the use of line identifier signs and the suitability of providing these above or below the aspect rather than to the side (as this may add to confusion).
- Determine why the driver was driving an unfamiliar route and investigate the potential for similar situations to arise - consider associated risk mitigations.

Part 2.3: Where factors associated with the signal itself contributed to the SPAD

2.3.1 If the signal is located within 10 metres of a tunnel exit

- Consider using an LED signal.
- Consider providing a repeater or co-acting signal in the tunnel if costs can be justified.
- Provide low level lighting in the tunnel to minimise the requirement for and the effects of visual adaptation.
- Improve conspicuity of the signal, for example, by using a bigger backboard.
- If the external environment provides few visual references by which speed could be judged, provision of count down markers could be beneficial (with spacing, and distance over which they are provided, appropriate to the speed and braking characteristics of the trains that they are designed to assist).
- Relevant Signalling Engineering Standards should be reviewed to consider providing guidance on positioning signals within 10m of tunnel exit.

2.3.2 If the signal is in a tunnel (where there may be insufficient lineside visual cues to support judgement of train speed) consider:

- Introducing low level lighting or other mitigations, to help with speed judgement. Consider the provision of small, dim lights at regular intervals along the inside wall of the tunnel.
- Painting small bricks with retro-reflective paint inside the tunnel.
- Improving the conspicuity of the signal, for example, by using an LED signal.
- If the external environment provides few visual references by which speed could be judged, provision of count down markers could be beneficial (Spacing, and distance over which they are provided must be appropriate to the speed and braking characteristics of the trains that they are designed to assist). Count down markers in the open air should be full size and at drivers' eye level wherever possible. Count down markers in tunnels should be reflectorised or lit. Where reflectorised count down markers are used, they must be located within the headlight beam, correctly aligned, and kept clean.

2.3.3 If the departure signal at the end of a platform is obscured or hard to see when the train is stopped at the car marker or normal stopping position

- Reposition car marker signs to improve signal sighting.
- Where necessary, consider cutting back the canopy or other platform furniture to improve sighting.
- Consider an upgrade of the guard's indicator lights to LEDs if the signal is regularly SPADed when starting away.
- Consider platform design.
- Improve signal sighting at stations.

2.3.4 If the signal is post mounted and set at a non-standard height

- Consider altering the height of the SPADed signal if this does not introduce further unacceptable risks. Ideally, signals should be in the driver's normal sightline, particularly signals of the same type, for example, post signals.
- Consider introducing a signal alert board.
- In extreme circumstances a co-acting signal may be considered necessary.

2.3.5 If the signal is located on the 'wrong side' of the track or positioned in an otherwise unusual location

- Consider the consistency of signal presentation along a stretch of track
- If the signal cannot be positioned on the usual side of the line (without creating sighting problems) then consider the use of an arrow to indicate the line to which the signal applies.
- Unusual signal positioning should be avoided unless there is a significant benefit to signal reading time and there is no risk of associating the signal with another line.
- Consider co-acting or repeater signals where costs are justified.
- As signals located on the wrong side are an exception to the rule, identify and include them as part of a driver's route knowledge. This is especially important where these are also platform starting signals.

2.3.6 If the signal beam is improperly aligned for the approach route

- Consider the use of spread lenses, fibre optic search lights, or LEDs, on curves to provide a wider viewing angle and longer distance viewing.
- Consider the use of LED lights for semaphore signals if a suitable specification is available. Maximise the light output of semaphore signals.
- Consider varying lens ranges to reduce the risk of misreading.
- Ensure that signal is maintained correctly, and obscured sighting holes are cleared when found.
- Regular checking of signal beam alignment is essential, both in daylight and at night. The intended alignment of each signal must be documented, and this information should be readily available to maintainers (for example, on signal head) who must also have a reliable means of checking and correcting the signal's alignment.
- Print alignment information on the signal.

2.3.7 If the signal lens was dirty or fogged (reducing the beam intensity)

- Consider using an LED signal.
- If there is a low filament output, check whether the voltage to the lamp is correct. Increase filament voltage if necessary. Most lamps are run at a voltage below their normal rating to extend their life a balance should be struck between reduced lamp life and increased brightness.
- Infrastructure maintenance staff and/or contracted maintainers should clean lenses and check the security and sealing of the signal head to exclude foreign matter (typically insects).

2.3.8 If there is strong ambient or background lighting which diminished the apparent brightness of the signal light

- Consider using an LED signal.
- Paint over white/reflective surfaces using a darker, matt colour for example, light grey.
- Consider using a large matt black backplate/background behind the signal to increase the opportunity for the driver to both locate the signal, and read its aspect.
- If possible, remove or shield the light source.
- Consider screening off non-signal lights from the track so that they cannot distract drivers.
- If signal cages are present, paint the structure, cages and gantry black and use a free standing backplate.
- Local staff/driver knowledge of emerging problems of this kind should trigger a new Signal Sighting Committee visit. Use of standard solutions for problems of glare/ghost aspects may be helpful in some cases (for example, where light reflections from buildings interfere with signal sighting). Shielding the source of glare may be possible, using larger backboards or side screening.
- Encourage drivers to report sources of distracting or disabling non-signal light sources.

2.3.9 If the driver's view of the signal was obscured by the presence of another train

- Determine if this occurs often and if so, consider raising the signal (if this does not introduce additional risk) or including a repeater signal. If the signal in rear of the SPADed signal is a permanent caution signal or does not provide the driver with information about the SPADed signal then consider resolving that issue.
- Consider proactive review of SPAD reports for different routes to identify at risk signals and consider signal sightings and relocation options for signals highlighted as being at risk (for example, raising signals, removing caution distant signals).