Reference material

Control of Trains Approaching Catch Points, Buffer Stops and Short Overlaps

This legacy document is published as historical reference material. The content described might be of assistance to individuals and organisations performing work on Transport for NSW Rail Assets.

This document refers to organisational and positional roles and responsibilities in place prior to 1 July 2013 and may have been superseded by other documents.

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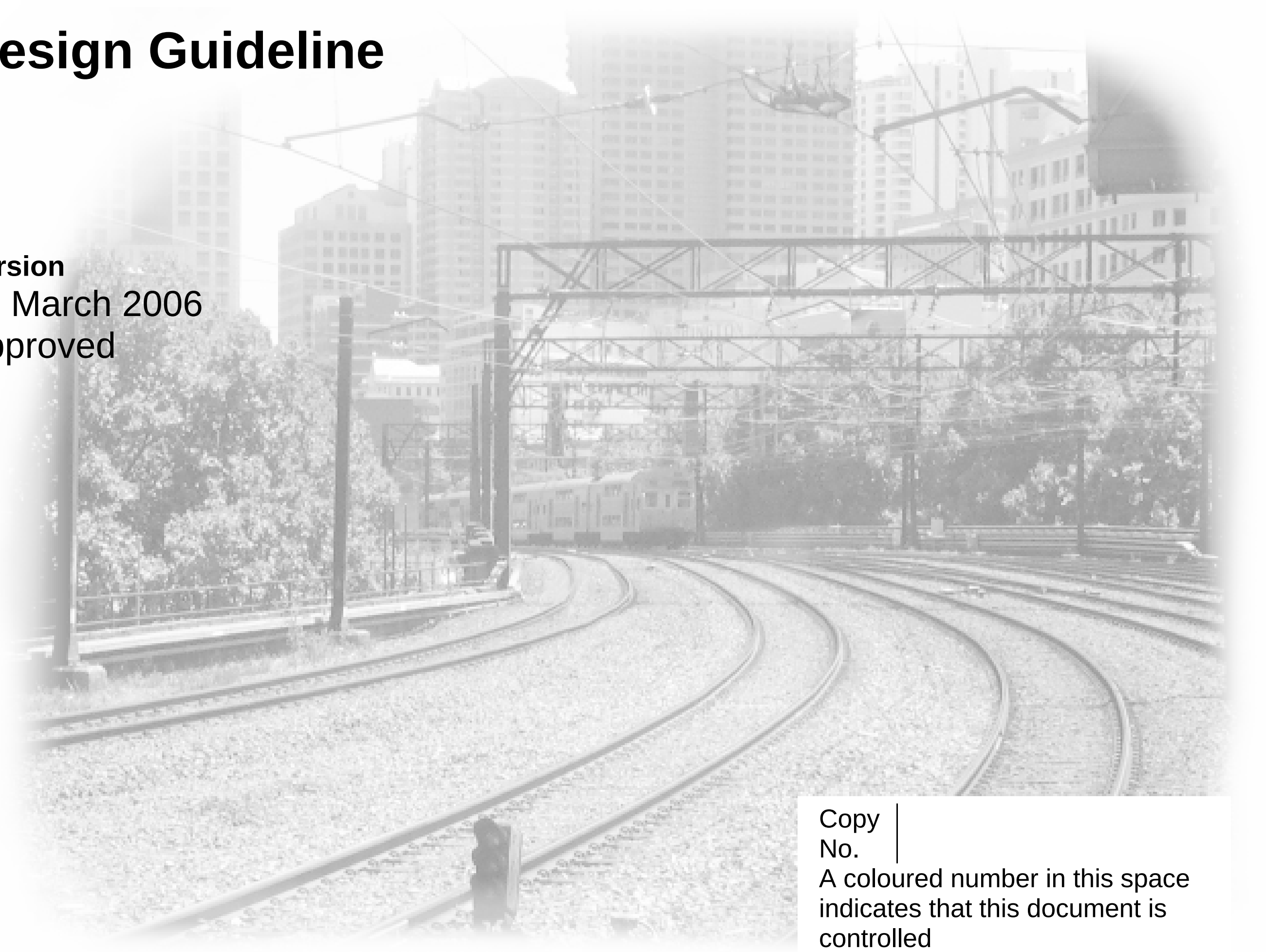
Signal Engineering

Control of Trains Approaching Catch Points, Buffer Stops and Short Overlaps

Design Guideline



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Design Guideline

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1 INTRODUCTION

As mitigation against trains running past signals at stop and derailing at catchpoints, conditionally cleared approach signals and intermediate train stops have been used to control train approach speed.

The arrangements that have had been designed usually are required to fit in with existing track infrastructure.

The results, while mitigating against high speed derailments at catchpoints, do not provide an operationally optimum solution.

This paper is to discuss alternative methods of achieving the requirements, with less (or minimal) operational constraints.

The methods are applicable to other locations with short overlaps and buffer stops.

2 REFERENCES

- Use of Train Stops to Control Approach to Catch Points RSA November1999
- Central Turnback Platform Approach Control of Trains 4 July 2001
- Risk Management Report – Overrun Protection at Passenger Train Sidings and Turnbacks – Minciv 2006

3 FUNDAMENTAL PRINCIPLES

The basic principle employed is that the mitigation provided is to match the speed of the train. This is an existing principle, but with the application extended throughout the system to other items, such as buffer stops.

Current applications of this are:

Event	**Mitigation**
Line Speed SPAD	Line speed trip braking overlap
SPAD after conditional aspect cleared	Short overlap to suit timing speed
Intermediate Train Stop (ITS) SPAD	Overlap to suit previous signal or previous ITS timing speed

New applications are:

Event	**Mitigation**
Train approaches buffers	Buffer to suit approach speed

4 CONDITIONAL CLEARING

Conditional Clearing is a useful tool in the approach control of train speed.

The benefits include being able to use existing signal aspects, and the control applies to all trains. This is important where non trip fitted trains operate, as a displayed aspect with train stop up does not have the same speed reduction impact to the driver, as a STOP indication.

However, if the aspect is permanently conditional, there is a risk that drivers may anticipate the clearing, and not be prepared to stop at the signal. This can result in the signal being passed at stop.

Where only trip fitted trains operate, the train stop enforces the stop signal such that any SPAD has a safe result.

However the arrangement can mislead drivers, and where unfitted trains operate, there is no check on train approach speed and hence adequacy of the overlap.

Consequently it is important that conditional clearing be used on a signal that is usually cleared to a full running aspect and that the conditional clearing is only in force whilever the condition exists that requires its use. The length of the timing track for conditional clearing speed checking should be kept consistent and within the range 160-220mm, adopted for the Sydenham resignalling project.

Full use of the available overlap should be made in that if it is suitable for a higher speed, then the timing should reflect the higher speed.

5 INTERMEDIATE TRAIN STOPS

5.1 ITS for Additional Speed Control

Additional speed checks can be provided by intermediate train stops. It is not readily apparent to the driver the speed that these are set at, and current practice is to provide intermediate train stop advisory speed boards to indicate the speed at which trains may pass.

Drivers, however, do not find it easy to maintain train speed while waiting for the train stop to lower and hence often unduly reduce speed in order to observe the train stop operate. This results in the train then travelling too slowly and after observing the train stop lower the driver may then accelerate, which is a potential loss of control scenario.

If drivers misjudge their speed, trip and stop, then the guard may open train doors at a platform without the train being fully in, while the driver attempts to restart and move the train up.

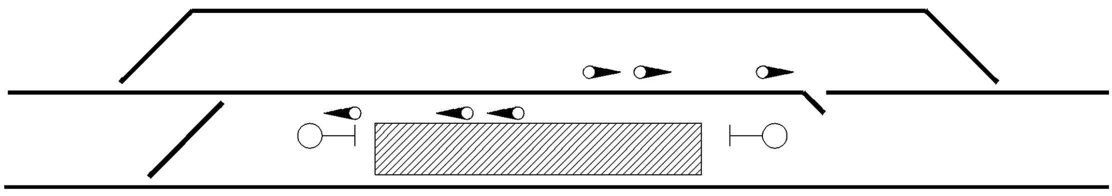
It can be difficult for drivers to judge speed correctly when the timing is performed while the driver is braking (ie reducing speed). Ideally train speed needs to be constant over the timing track circuit.

Additionally, DPU timing arrangements for intermediate train stops have proven to be not as reliable as desired, so use of a CSEE D50 wheel treadle for this purpose has been trialed.

In general, intermediate train stops impact on the natural way drivers are expected to control their train, and while mitigating gross overspeeds, does not present an ideal solution, nor prevent the train from running out of catchpoints.

5.2 ITS For Catchpoint Protection

Where intermediate train stops exist in platforms, and trains may need to travel either way, trainstop provided for one direction may back trip trains for the other direction.



These ITS are provided to prevent catchpoint runoff in tight situations. Short (4 and 6 car) trains are prevented from achieving any run up by the additional ITS located just past the 4 and 6 car mark. If these trainstops are suppressed for departing trains, this protection is removed just at the time it is most likely to be required, should the train move the wrong way.

Millennium trains back trip at quite low speeds. If a train is brought to a stand prematurely by an intermediate train stop there is the chance the guard may open the door without all doors being at the platform.

Additionally, the train may still be on a track circuit that holds points and thus prevent following movements.

It may be permissible to suppress the inner trainstops if track circuits can prove the train length as being past the ITS, or the risk is otherwise acceptable.

5.3 Train Stop Operating Times

All calculations must allow for train stop operating times and system operating times. Train stop operating times may vary. For example, hydraulic types may take longer in cold weather, when the oil is less fluid and have operating time allowances are of a general nature. System operating times are important in CBI systems (eg. 1 second cycle time in SSI systems).

Train stop operating time allowances to drive reverse should be:

EP - 0.5s

Other - 1s

Trainstops may take 2-3s to restore to the normal position.

6 TIMING METHODS TO CHECK TRAIN SPEED

The use of track circuits to provide train speeds by timing is always a compromise.

Early installations used existing track circuits of varying length, which were provided to suit other design criteria.

The track circuit can only ever assess an average speed and hence if the track circuit is long, trains may enter the timing point quite legitimately at a higher speed, and then have to reduce speed substantially below the design timing speed in order to achieve the design average.

The result of this is that the train may need to stop and wait for the timing to elapse.

Also a train may stop on the approach and time out, with the subsequent restarting of the train not then subject to the timing control.

Conversely short timing tracks are able to much more accurately 'sample' the speed at the required (or closer to the required) point to achieve trainstop operation. This results in drivers not being able to view the trainstop drop ahead and hence they may slow down to achieve this.

However this approach would result in a better train speed profile if the driver could 'trust' the operation of the system.

If a problem exists with DPU timing reliabilities, however, a small delay in train shunt can result in a significant impact on the timing and hence driver judgement would rank the installation unreliable.

If reliability of timing is assured, and intermediate train stop advisory speed boards provided, the use of a short timing distance prior to the trainstop would enable drivers to gain some respectable familiarity and trust in operation and is hence seen to be the optimum arrangement with this technology.

Timing is usually set to 5 seconds which is the minimum feasible using a QTD5 relay while still allowing some adjustment of the timer either lower or higher.

7 SPEED CONTROL CONFIGURATIONS

7.1 Criteria to be Applied

The aims of any speed control arrangement should be to:

- Not unduly impact on normal driver behaviour
- Prevent major incidents
- Control the train speed to suit the conditions ahead
- Be reliable
- Reduce, as far as is practical, reliance on the driver having to observe the trainstop
- Avoid conditional clearing which may increase the incidence of SPAD.

As a fundamental principle, the speed of the approaching train needs to proven to be at, or below, a speed that the overlap can mitigate.

Additionally a catch point should be used as a control for events beyond the usual criteria for system design.

For example, it is usual to:

- Not apply acceleration after a speed check in above ground installations
- Apply overlaps only to a maximum of line speed
- Use the GE52A curve for overlap braking calculations above ground.

In underground areas, it is usual to:

- Apply acceleration after a speed check and an overlap accommodating this higher speed
- Use the GE52 curve
- Cap acceleration at the line speed.

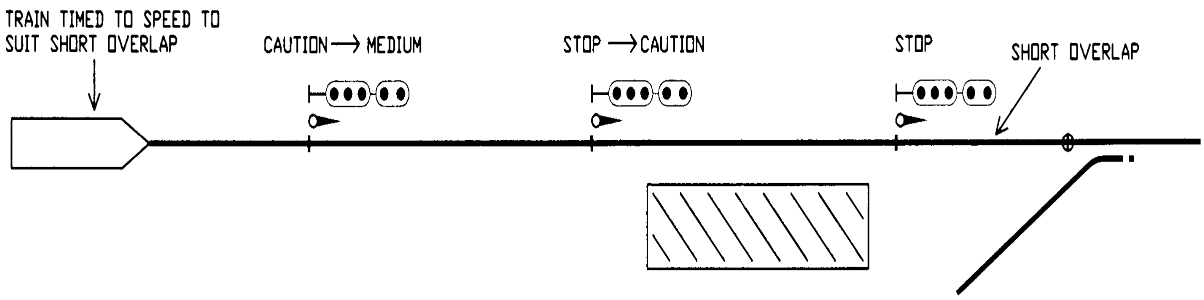
Should events occur outside these criteria mitigation is less assured and may be by:

- Use of a catch point
- Having an overlap longer than a minimum
- Having a very low probability that a previous train would stop hard on an overlap point.

7.2 Conditional Mediums

Where trains may approach a short overlap, and it is desired to advance trains (for example into a platform) and no non trip fitted trains operate, then a conditional medium can be applied.

In this arrangement, a train approaching a caution signal may be proved to be travelling sufficiently slowly to permit a signal ahead to clear from stop to caution, and thus permit the caution indication the train is approaching to step to medium.



For this to be effective, the train must be well in advance of the conditional medium signal so that the driver may observe the indication.

A point about 100m before the signal would be suitable for this to occur. Should the train miss this timing point, the usual conditional caution clearing would apply at the following signal.

Such a conditional medium would require a timing start and finish point, and hence two D50 wheel detectors located 5 seconds travel time apart (or a suitable track circuit) at the required speed are necessary.

The use of Conditional Medium's should be decided on a case by case basis and include consideration of the following criteria:-

- Length of Overlap – minimum margin of safety must be maintained, particularly in the case of flank protection.
- Track Gradient – rising grade tempts driver to accelerate – failing grade demands greater braking control over train.
- Distance from Conditional Medium signal to stop signal – risk of train accelerating if too far.
- Train accelerating at or past timing section, which may be due to starting from a station, controlled signal, permanent speed restriction, etc.
- Operational advantages vs risk disadvantages – is it worth the gain and is the additional gain outweighed by the additional risk.

Conditional mediums were extensively used on the Harbour Bridge 1932 – 1990.

7.3 Intermediate Train Stops With Reducing Speeds

When train speed is needed to be checked using intermediate train stops to progressively lower speeds, the driver is provided with a low speed indication that advises the driver to proceed at 25km/h or less.

While not explicitly stated in the rules, it is common practice for the train to then experience further checks using intermediate train stops when the overlap is only suitable for a low speed.

The speed at which the intermediate train stops are timed is provided to the driver on an intermediate train stop advisory speed board at the commencement of the timing point.

Consequently the driver can proceed at a constant speed over the timing track and expect the train stop to operate.

This is a significant improvement over previous installations where no speed advice is provided and the train stop is located on an otherwise potentially ill defined braking curve.

However, it is essential for the timing to be reliable, and hence use of DPU's in not now recommended.

The arrangements for intermediate train stops in above ground situations is detailed in the document "Use of Train Stops to Control Approach Speed to Catchpoints – 1999". The arrangement when acceleration is to be allowed for (eg tunnel situations) is described in "Central Turnback Platform 23".

7.4 Line Speed Checking

7.4.1 Train Stop Up

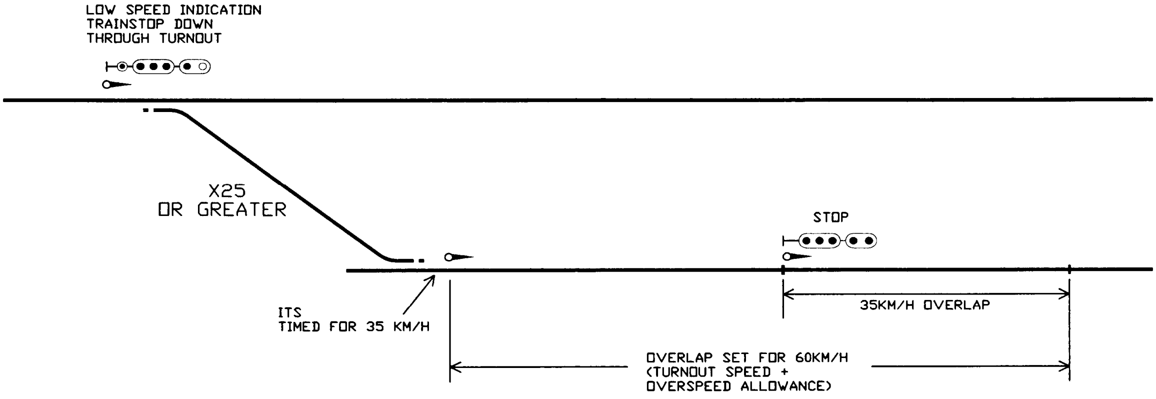
Some circumstances may exist where line speed checking can be employed. The benefit of this is that no special signal aspects need to be displayed, nor speed boards, as the normal operation of the train is being confirmed.

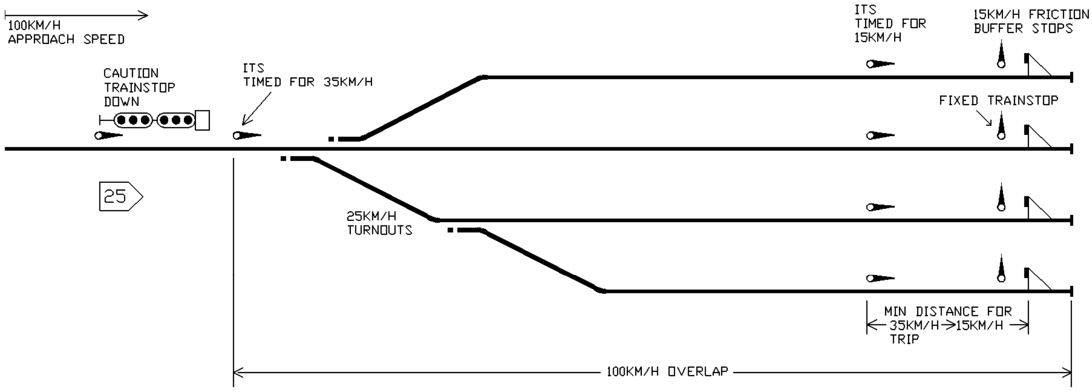
The problem with such an arrangement however is that drivers may not particularly like approaching a raised train stop, however it may be preferable in some circumstances to providing conditional low speed signals.

The line speed may be set by speedboard or a turnout on the approach.

If the timing is set for a higher speed, than the line speed (ie the available overlap is longer than the line speed overlap) then the train stop will lower before the train reaches it, providing greater confidence for the driver.

The following situations may use a line speed checking train stop:





CONTROL OF TRAINS APPROACHING BUFFER STOPS & SHORT OVERLAPS

In these cases the 35km/hr is chosen as it is above line speed, but suitable for the overlap ahead.

Note the 15km/h trainstops can be located a short distance in front of the buffer stops as their role is to be able to reduce a train travelling at 35km/h (in the example) to 15km/h before collision with the buffer stop. This location should be well past the braking point for a normal approach and hence the trip would be down before the driver reaches it, permitting greater assurance for the driver.

7.4.2 Train Stop Down

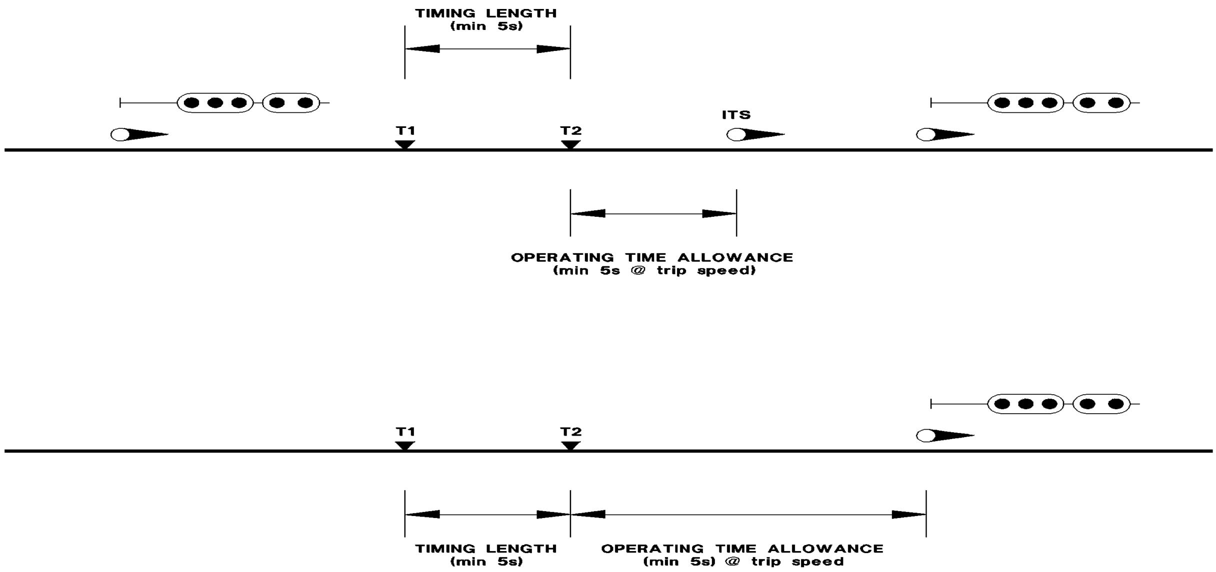
As an alternative, the use of train stop raising in front of the train may be considered. With this concept, if the train does not meet the timing criteria, the train stop drive is removed, and the arm rises and the train trips. The train stop may be the normal train stop at a signal.

A suitable distance between the second timing point and the train stop needs to be provided to ensure adequate time for the train stop to raise, at the maximum speed if is required to cater for (Note: this may be higher than line speed).

While 5sec is the minimum timing length, timing accuracy will improve if a longer distance is used at higher speeds. The sensitivity of any proposed arrangement should be calculated to ensure the limits are understood.

The train stop should be proven to cycle for each train and its operation proved. A timer should also be provided to ensure that the time it takes to restore once the drive is removed is monitored and alarmed if excessive.

To date this method has not been implemented.



7.5 Friction Buffer Stops

The use of friction buffer stops can assist in mitigation of low speed overrun. A short overrun track is provided and the buffer stop design must be integrated with the approach train speed. Typically 8km/h friction buffer are suitable for sidings, with 15km/h being close to the most practical application with cost and space. However, 25km/h buffer stops are available. The required space behind a friction buffer stop for the impact speed must be provided.

Typical distances are:

8km/h	10m
15km/h	15m
25km/h	33m

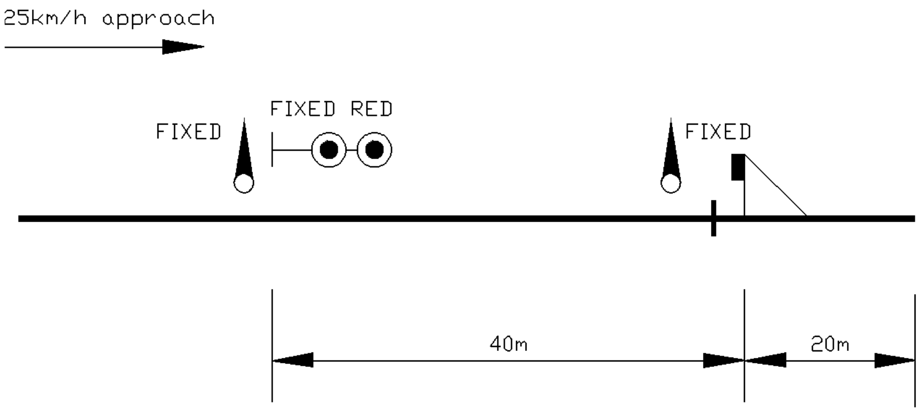
These distances include the buffer stop structure length, but may vary with manufacturer and other criteria. Designers should ensure that buffer stop speed and distance specifications are clearly identified in designs.

7.6 Use of Short Overlap and Friction Buffer Stop

Where an overlap is provided, but is not sufficient for the approaching train speed, a friction buffer may be used to mitigate the excess speed.

In the example below, there is 60m beyond the train stopping point, which is marked by a fixed red signal and fixed trainstop. If a 15km/h buffer is located at the 40m location, then the 40m can be used to mitigate a speed of 25km/h to 15km/h, with the friction buffer mitigating the final speed.

This arrangement then needs no intermediate train stops providing the train approach speed has been checked at 25km/h.



8 RISK ASSESSMENT

The principles and methods in this document are supported by a Risk Management Report entitled “Overrun Protection at Epping and Chatswood Turnbacks” by Minciv Management Services Pty Ltd, December 2005.

For scenarios not covered by this document and the risk assessment, a new risk assessment may be needed to properly assess the specific situation.

9 CONCLUSION

This paper is to show different techniques that can be employed to improve driver response on speed controlled signals and intermediate train stops.

The concept of speed proving for the available overlap remains.

Signal designers should aim to influence track designers in the provision of suitable overlaps and overrun measures to suit operational arrangements.