SUMMARY

In Australia there are approximately 8000 public level crossings, around one-third of these have active warning devices that warn a road user of an approaching rail vehicle (a train); the remainder have only passive signs which do not change state as a rail vehicle approaches. There are a number of programmes underway in Australia to provide funding to install active warning devices at level crossings where previously there has been only passive warnings. This paper looks at the benefits of installing active warning devices at level crossings, and raises the question of when it should be considered that active warning devices are not required at a level crossing.

The theme of this paper is a discussion of the cost-benefit of installing high-cost warning devices at level crossings and provides a discussion of the current situation in Australia. The paper presents the personal views of the author and does not necessarily represent the official position of any railway organisation in Australia.

1 REASONS TO HAVE BOOM GATES

1.1 Active Warning Devices Can See Around Corners and Can See Second Trains

There are a number of situations where active warning devices – in particular a boom gate assembly – provides the most effective form of warning at level crossings. Most importantly is the fact that active devices can warn road users of an approaching rail vehicle (a train) even when the rail vehicle is not visible to a road user. For example if the railway line is obscured from the line of sight of a road user stopped at the level crossing then some form of active warning is clearly required to ensure that the road user can cross the level crossing safely. This is a particular concern in Australia where road trains can be over 50 metres long and weigh over 130 tonnes (for the sake of comparison, trucks in Australia can be three times longer, and three times heavier than the legal limits in the UK). In such situations very long sight distances can be required to allow a road train to safely pull away from a complete stop, traverse and clear a level crossing before a train arrives. Often such long sight distances are not available at the road traffic holding point and therefore some form of active warning is required. See Conclusion 1.

Similarly where a level crossing can have simultaneous train movements on more than one railway line, then there is a possibility for a second train approaching the level crossing to be obscured from road users’ view by the first train departing. This can lead to a very dangerous situation where road users often believe that the rear of the first train indicates that the level crossing is clear, and proceed into the path of the second train. In these situations, active warning equipment provides an important safety control by warning road users of the second train. Furthermore boom gates provide a clear means to show road users that the first train departing does not mean that the level crossing is clear.

It should be noted that in Australia, many of the level crossings that have no active warning devices have only a single railway line and are located in open country where there are no obstructions to visibility. Therefore there are a very large number of level crossings where the benefit gained from active warning devices may be limited. A well-managed programme of level crossing safety therefore needs to consider the specific risks at each level crossing before determining the most effective, and cost-effective, means of warning. See Conclusion 4.

1.2 “The Railways May Have a Duty of Care to Road Users, and May Face Litigation in the Future For Not Providing Boom Gates”

A concern for many railway companies is that the legal obligations of railway infrastructure managers is not clear. It is often argued that, since a collision at a level crossing has an increased likelihood of a high-consequence accident when compared with a collision at a road-to-road junction, the railway infrastructure managers have a duty of care to provide the best warning devices that are available; and therefore that boom gates should be provided at all level crossings. However this argument is unclear in two regards: firstly it is not clear that railways necessarily have the burden of responsibility to protect road users from every folly of their own actions. If a road
user has sufficient sight distance to make a safe decision whether or not to cross a level crossing, it is not clear that the railway should necessarily be going to the expense of providing additional information: after all there is no need to provide traffic lights at every road-to-road intersection. Secondly, there is no clear information available to show that active warning devices in Australia necessarily provide better protection than passive devices.

Since the law is not clear on the responsibilities of rail infrastructure managers, and since the available evidence in Australia is mute on whether active warning devices provide any better protection, it is not uncommon for railway infrastructure managers to install boom gates “just to be safe”, out of fear of potential future litigation if they don’t. See Conclusions 3 and 6.

2 REASONS NOT TO HAVE BOOM GATES

2.1 Boom Gates Can Create Hazards

There are some situations where boom gates can increase the hazards at a level crossing. One example is where there is a high likelihood of queuing over a level crossing. A descended boom gate provides a sense of entrapment to road users who are queued on a level crossing when a train approaches. In most cases there is no real entrapment: two-quadrant boom gates are overwhelmingly more common than four-quadrant boom gates in Australia. Furthermore, most road vehicles can readily break a boom gate by simply driving at it. Lastly there is no design of boom gate in Australia that cannot simply be crawled under by a person with any degree of mobility. Nevertheless the sense of entrapment can be very real in the minds of people who are on a level crossing in the path of an approaching train, and this sense of entrapment has been a direct cause of a number of fatalities in the past.

Another instance where boom gates can create hazards is where there is a high likelihood of road users wanting to race in front of the train. On Australia’s expanding network of coal railways, coal trains can be more than two kilometres in length: travelling at 60 km/h, this means that a coal train can take more than two minutes to traverse a level crossing. Adding the 30-second activation time for active warning devices can lead to a situation where road users feel they are being intolerably delayed by a level crossing. In these situations road users often feel motivated to attempt to race in front of the train. The presence of boom gates in such situations means that road users are spending more time in the path of the train than they otherwise would.

It may be argued that the folly of road users who disobey boom gates (and in doing so disobey the law) should not be a consideration for railway infrastructure managers. But, as discussed above, freeing railway infrastructure managers from the burden of protecting road users from their own errors can be argued as a reason for never installing the boom gates in the first place.

2.2 Low Cost-Effectiveness

The major objection to the widespread use of boom gates in Australia is economic. The best available data, References [1] and [2], suggest that the number of fatalities at level crossings in Australia which have only passive warning devices is between three and seven. This is an approximate number since the data are not of high quality. See Conclusion 6.

Similarly the cost of installing active warning devices is not easy to determine; however it must be remembered that many level crossings in Australia are in very remote areas where there is no active signalling equipment. To install automatic train detection systems (such as track circuits or axle counters), and provide the very long cable runs necessary to provide power can lead to very high costs. Estimates from the safety manager of one of Australia’s largest railways indicate that to install active warnings at all level crossings where there is currently only passive warning devices would, at current prices, cost approximately $11 billion Australian dollars (AUD).

Whilst the exact number of fatalities at level crossings with passive warnings in Australian is not clearly known, and whilst the exact cost of installing active warnings is not known, the remainder of this discussion will assume that seven people per year are killed in accidents at level crossings with passive warning devices. It will also be assumed that the costs to install boom gates at all the level crossings that currently have only passive warning devices is $11 billion AUD. For the sake of determining the potential cost-benefit of boom gates in Australia, this
discussion will also make the unrealistically optimistic assumption that installation of boom gates will completely eliminate all fatalities at level crossings that currently have only passive warnings.

Hypothetically, if boom gates were installed at every one of Australia’s passive level crossings, each boom gate installation had a useful life of 30 years, and the programme of installations resulted in seven fewer fatalities every year, this would be a reduction of 210 fatalities at a cost of $11 billion AUD: more than $50 million AUD per fatality prevented. It is not clear that such a high willingness to pay would present a valuable use of public funds. To provide a comparison of the safety risk that passive level crossings pose in Australia, Table 1 shows selected causes of death for Australians in 2009 taken from Reference [3].

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Total</th>
<th>Total ÷ 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidental poisoning by and exposure to noxious substances</td>
<td>799</td>
<td>114.1</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>2799</td>
<td>399.9</td>
</tr>
<tr>
<td>Thyroid disorder</td>
<td>135</td>
<td>19.3</td>
</tr>
<tr>
<td>Mental health disorder</td>
<td>6522</td>
<td>931.7</td>
</tr>
<tr>
<td>Parkinson’s disease</td>
<td>1194</td>
<td>170.6</td>
</tr>
<tr>
<td>Inhalation and ingestion of food causing obstruction of respiratory tract</td>
<td>56</td>
<td>8.0</td>
</tr>
<tr>
<td>Inhalation of gastric contents</td>
<td>31</td>
<td>4.4</td>
</tr>
<tr>
<td>Fall on and from stairs and steps</td>
<td>50</td>
<td>7.1</td>
</tr>
<tr>
<td>Fall involving bed</td>
<td>28</td>
<td>4.0</td>
</tr>
<tr>
<td>Fall on and from ladder</td>
<td>13</td>
<td>1.9</td>
</tr>
<tr>
<td>Other fall on same level</td>
<td>18</td>
<td>2.6</td>
</tr>
<tr>
<td>Fall involving other furniture</td>
<td>10</td>
<td>1.4</td>
</tr>
<tr>
<td>Drowning and submersion while in bath-tub</td>
<td>10</td>
<td>1.6</td>
</tr>
<tr>
<td>Exposure to excessive natural cold</td>
<td>24</td>
<td>3.4</td>
</tr>
<tr>
<td>Other and unspecified firearm discharge, undetermined intent</td>
<td>18</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Table 1: Selected Underlying Cause of Death for all Australians 2009, source ATSB [3]

As Table 1 shows, everyday activities (such as getting out of bed or eating dinner) kill many more Australians than are killed at passive level crossings (four times and eight times respectively). Australia is famous for its hot climate, yet more than 20 people died in 2009 from exposure to cold weather: 3½ times more people than are killed at passive level crossings. When considering the danger from more common, and preventable, causes of death such as breast cancer or thyroid disorder it is far from clear that the very high cost required to install boom gates at all level crossings in Australia could be a justified use of public funds. See Conclusion 2.

Clearly the cost effectiveness of boom gate systems would increase if the cost per installation were to reduce. Modern technology is providing a number of ways that boom gates could be installed for a fraction of the cost of the systems that are currently being used. Using innovative systems for train detection and based on solar power supplies, the new generation of low-cost level crossing warning devices (LCLCWDs) may provide a practical way to install boom gates, particularly in Australia’s remote country areas, where it is currently not feasible. Whilst LCLCWDs can cost 10% or less of the cost of an existing boom gate installation, many of the systems available don’t provide the high (“SIL 4”) degree of protection against failure that exists in current systems. Work is underway (see Reference [4]) to determine the complex legal and social issues that may arise from providing lower cost boom gates if that also involves a possible increase in wrong-side failure rates of the equipment.
Nevertheless, the new technologies present a promising way forward for rail safety and should continue to be thoroughly investigated to determine their potential usefulness as a cost-effective safety control. See Conclusion 5.

2.3 Uncontrolled Use of Boom Gates Can Create an Unrealistic Precedent

A final argument against the installation of additional boom gates is that it may not be valuable to Australia to establish a precedent whereby boom gates are installed as a matter of course at all level crossings. By comparison, although coloured traffic lights are very common at road-to-road intersections, there is no intersection between two public roads in Australia where boom gates are used to provide warning that road traffic is approaching on the other road. Arguably there are many more situations on Australia’s road network where boom gates could provide a useful safety control than there are on the railway network.

If boom gates were installed unthinkingly at every railway level crossing, it logically raises the question of why boom gates shouldn’t also be used at road-to-road intersections, especially those intersections where traffic lights are currently installed. Following this line of reasoning can lead to the conclusion that boom gates should be installed for any intersection between road traffic and any other vehicle: such as pedestrian crossings, or even junctions where private property joins a road. Such an absurd approach highlights the fact that whilst boom gates can be an effective control in some situations, it is clear that they should not be used in every situation where they could be used, indeed they should not even be used at every railway level crossing where they could be used: only at those level crossings where they can provide a meaningful improvement in safety.

3 CONCLUSIONS

The discussion presented in this paper leads to the following conclusions:

1 There are a number of situations where active warning devices at level crossings is essential to ensuring safety. In these situations active warnings should always be used and furthermore boom gates – as a form of active warning – should be considered as a method of improving safety.

2 Boom gates are not a perfect solution: they are not 100% effective in eliminating fatalities; and they are very expensive. It is not clear that the installation of boom gates is a cost-effective use of public funds when compared with other safety schemes.

3 In some cases railway infrastructure managers in Australia are installing boom gates primarily out of fear of potential future litigation. However there are no clear legal guidelines for railways to determine what their future liabilities may be. As such, railways may be spending public funds out of fear rather than in the best interests of public safety.

4 There is a need for robust safety risk assessment to be applied at every level crossing to determine the need for active warning devices.

5 New technology, low-cost, warning devices may significantly increase the value-for-money that can be obtained from installation of boom gates.

6 In Australia there is poor data available to determine the effectiveness and cost-effectiveness of the protection provided by boom gates. Investment in a programme to collect better quality data should be considered to be an essential part of establishing an informed programme of level crossing safety in Australia.
4 REFERENCES


[3] Causes of Death, Australia (3303.0); Australian Bureau of Statistics (ABS); accessed from ABS website www.abs.gov.au; September 2011