Human Factors at Level Crossings

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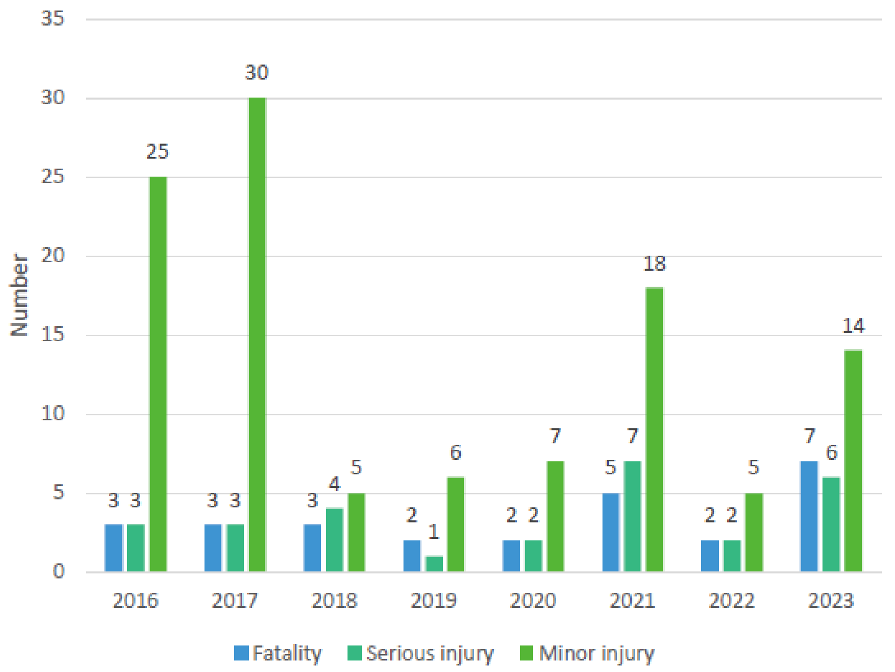
Overview

- Fatality rates at level crossings
- AS7658 guidance
- Issue of excessive warning times
  - Shane Warne
  - LX scenario 1
  - LX scenario 2
- Increased risk identified
- Other factors – minimum warning times
- Current situation - inertia

TOTAL LEVEL CROSSING OCCURENCES ON THE AUSTRALIAN HEAVY RAIL NETWORK 2016-2023[1]

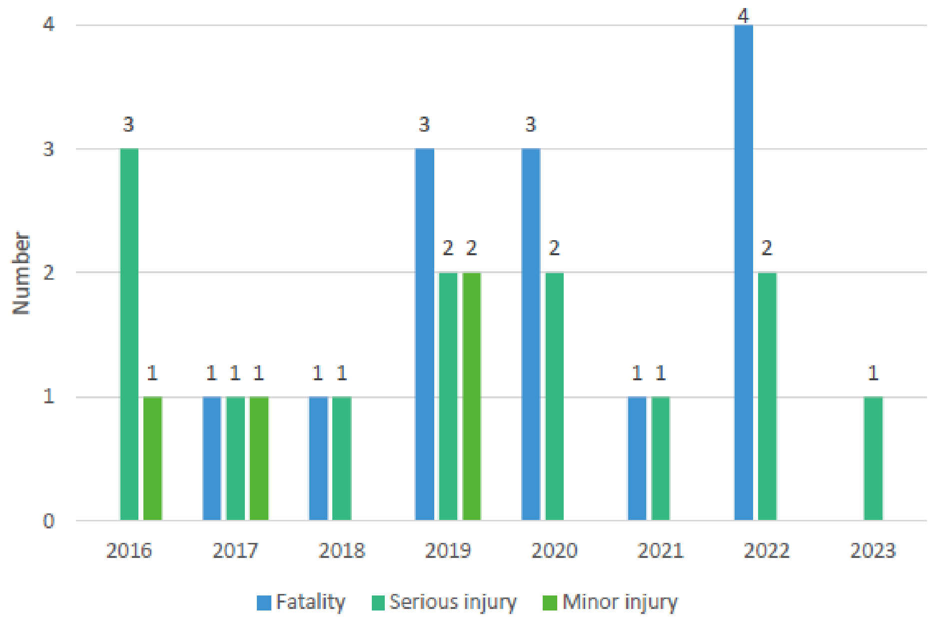
COLLISION WITH A ROAD VEHICLE

In this period there were 27 fatalities and 138 injuries because of road vehicle collisions at a level crossing.



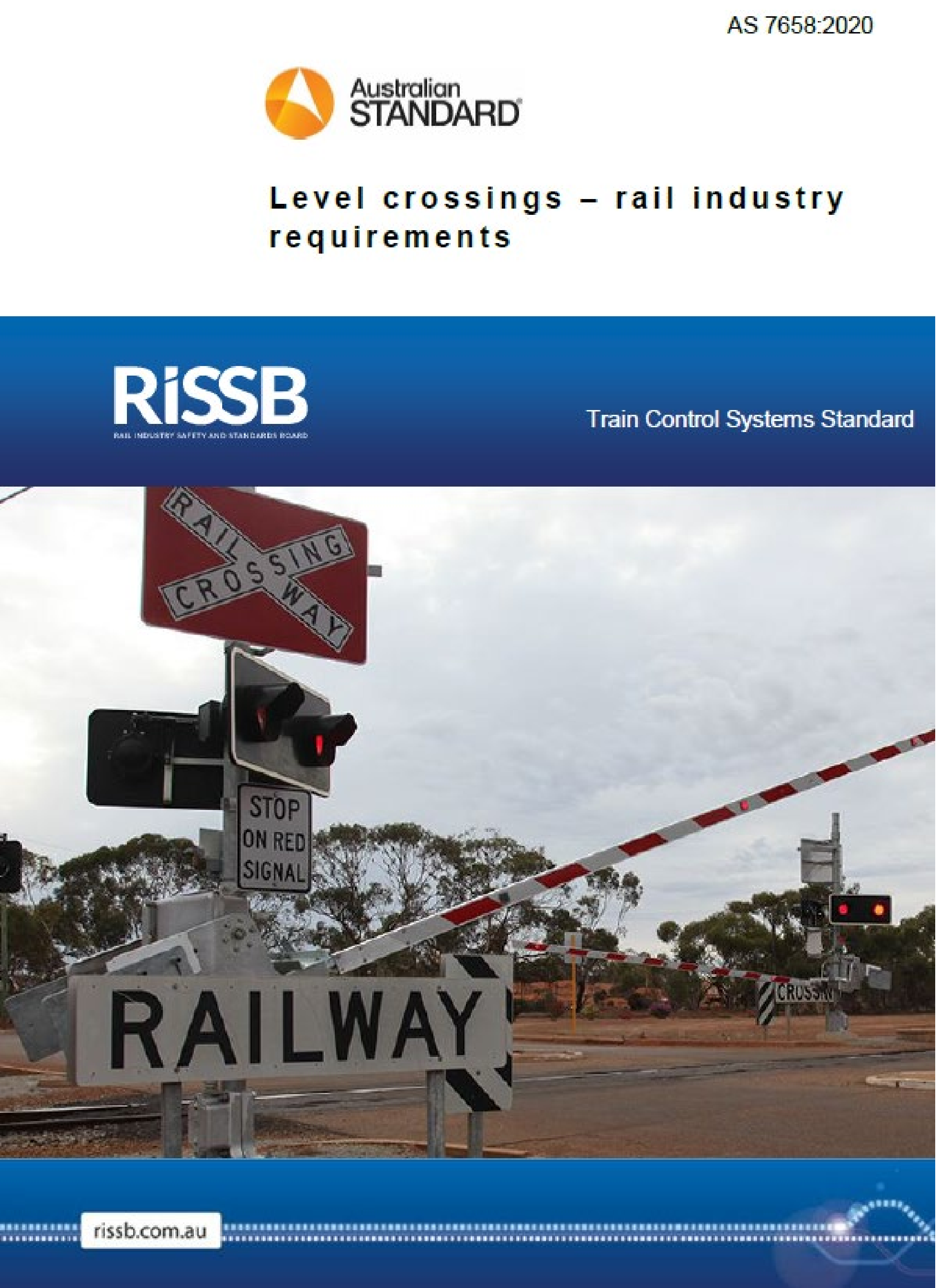
COLLISION WITH A PEDESTRIAN

In this period there were 13 fatalities and 17 injuries because of collisions with a pedestrian at a level crossing



1. Office of the National Rail Safety Regulator, Occurrence extract-fatalities, serious injuries, minor injuries, attempted suicide no consequence July 2015–December 2023. The requirements for operator reporting of notifiable occurrences are set out in the Reporting Requirements for Notifiable Occurrences. See here for information about notifiable occurrences. On 1/7/2022 the definition of serious injury changed potentially changing reported serious injuries compared to previous years.

TrackSAFE Foundation



Principles (AS7658)

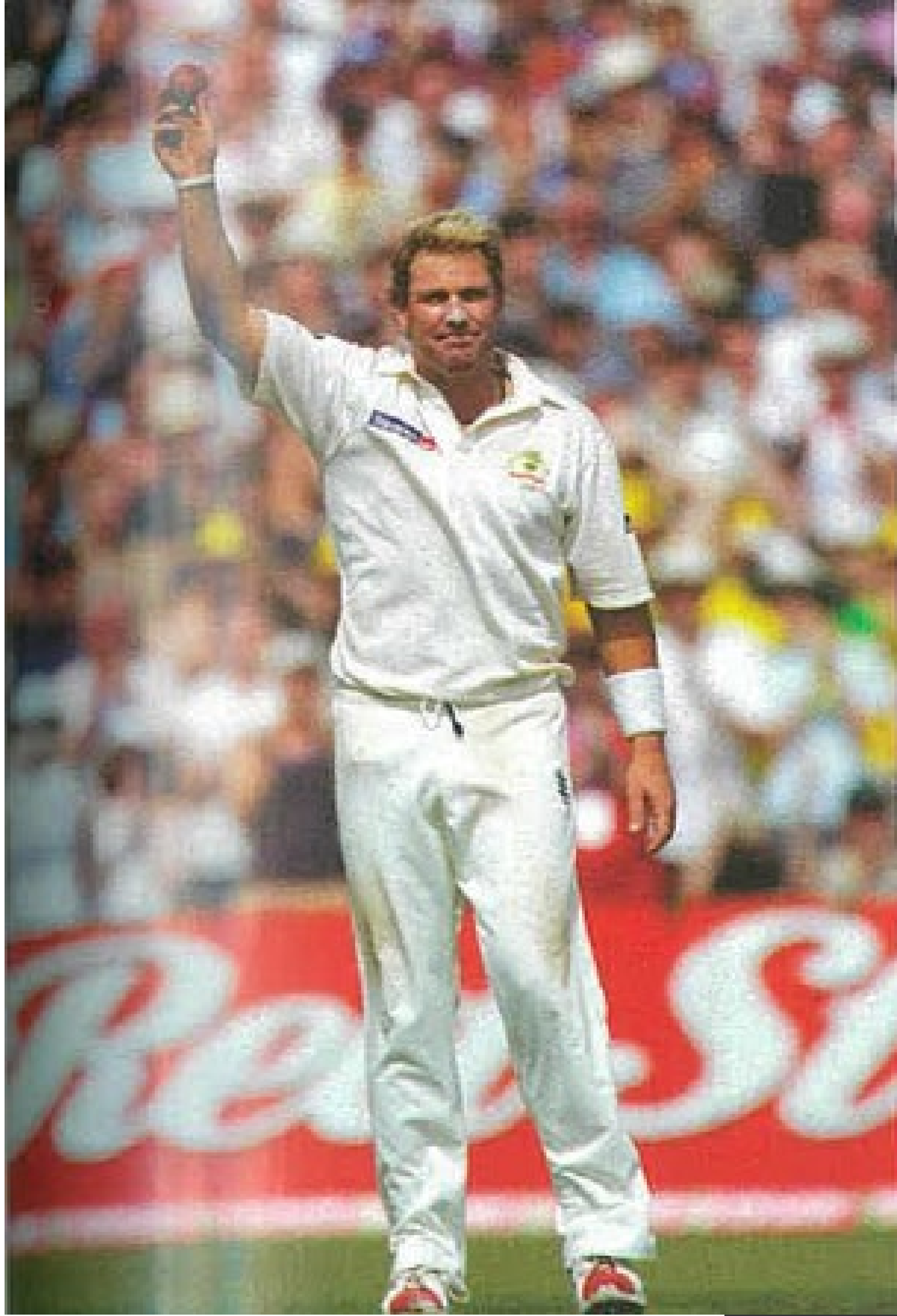
- Clause B.1 states:
  - “The design of an active level crossing shall use a calculated minimum warning time that evaluates the following timing factors at the particular level crossing:
- Subclause (a) then goes on to state:
  - “The minimum warning time between the commencement of the level or pedestrian crossing activation and arrival at the level or pedestrian crossing of the fastest train shall be 20 seconds.” Provide additional measures (SFAIRP) to ensure compliance
- Clause B.1 then further goes on to state:
  - “Where reasonably practicable, the design warning time should not exceed 50 seconds.”
- Finally, also Clause B.1 (Subclause (b)):
  - For level crossings wider than 15 m, an allowance of 1 second for every additional 3 m, or part thereof, of width shall be included.

Shane Warne Effect

- “The art of leg-spin is creating something that is not really there. It is a magic trick, surrounded by mystery, aura and fear. [The batsman must think about] what is coming and how will it get there? At what speed, trajectory and with what sound, because when correctly released, the ball fizzes like electricity on a wire! How much flight, swerve, dip and spin and which way? Where will it land and what will happen?”

- “... Leg-spinners cannot create physical fear, in the way fast bowlers can, so they look to confuse and deceive. The intimidation factor in spin bowling comes from a batsman's ignorance and consequent fear of embarrassment.”

- “The Gatting ball is a rare thing because usually it takes time to nail a good player, especially if he's already settled when you first come on to bowl. You kind of have to stalk him and then set him up. If a guy is a good sweeper, your line has to be outside off-stump, spinning away, with six fielders on the off-side, and your length has to be fullish so he feels compelled to cover drive instead. By starving him of an easy ball to sweep, you challenge him to fetch it from dangerously wide of his go-to zone, and then, when you sense the frustration is eating away at him, you bowl faster and straighter, saying, 'There's the line you're looking for, mate, go for it.' I've hit the stumps and the pads more than a few times with a straightforward plan like that.”



Shane Warne Effect

- Dismissal investigation finding:
  - Batsman error (“he didn’t get properly to the pitch of the ball”)
- Bowler contribution (average wicket rate for test matches)
  - Shane Warne: 9.6 Overs per wicket
  - Greg Chappell: 18.9 Overs per wicket
  - Batsman (other): 30 Overs per wicket
- Risk of dismissal is 2 – 3 times as high when facing Shane Warne.

Level Crossing Scenario 1

Ambulance Crossing at Level Crossing subject to excessive operation

- **Ambulance crossing at level crossing subject to excessive operation:**
  - Critical case (need to reach patient with eg “breathing problems”)
  - In 20% of cases (50% minus 30%) the ambulance will find itself stopped at the crossing in a case where it would not have been stopped had the design avoided having the outcome of excessive operation. Safety is provided by LX warning operating
- Option 1: Wait for the booms to lift
  - For the incident scenario described here, the expected outcome would be that the patient would die. The delay of, say, “a couple of minutes”, would likely cause the lack of oxygen to become fatal.
- Option 2: Run around the booms against the flashing light warnings
  - expected outcome would be that the patient would be reached in time and likely survive
  - However there is also a risk that a train will collide with the ambulance as it attempts to cross at the level crossing
- Option 3: Design the crossing operation to avoid excessive operation
  - For the incident scenario the lights and booms will not have commenced operation yet when the ambulance arrives at the crossing
  - the ambulance will cross at the level crossing without incident and without risk
- **Option 3 provides highest level of safety**

Level Crossing Scenario 2

Pedestrians utilising Level Crossing subject to excessive operation

- **Pedestrians utilising level crossing subject to excessive operation:**
  - School children are required to use the down end pedestrian crossing to cross both tracks to reach platform and catch train
  - Up trains can on occasion be held for some time at the previous station (which the designer has unnecessarily included as part of the holding section)
  - Being habituated to the situation where the up train takes a number of minutes to arrive, the schoolchildren will have an incentive to try to bypass the closed gates. Being inventive they will likely succeed and, 999 times out of 1000 catch their train (even in the face of measures such as gate locks)
  - On that 1 time in 1000, the up train will not be waiting at Noarlunga platform but on the approach to the crossing (obscured from view temporarily by the down train which has just passed). A child will cross the tracks in the habitual way and be hit by the up train.

- Option 1: Wait for the gates to open
  - After waiting (typically multiple minutes with no train), train students need to catch crosses the crossing, stops at station and is missed.
  - Students are late for school/ HSC Exam, etc.

- Option 2: Jump gates and run to platform
  - expected outcome would be that the student would reach the platform in time, catch the train and not be late
  - However there is also a risk (1 in 1000 say) that a train will collide with the student as he/she attempts to cross at the gates

- Option 3: Design the crossing operation to avoid excessive operation
  - For the incident scenario the gates will not have commenced operation yet when the ambulance arrives at the crossing
  - the students will cross at the level crossing without incident and without risk

- **Option 3 provides highest level of safety**

Level Crossing Cases

Pedestrians utilising Centre Rd, Bentleigh

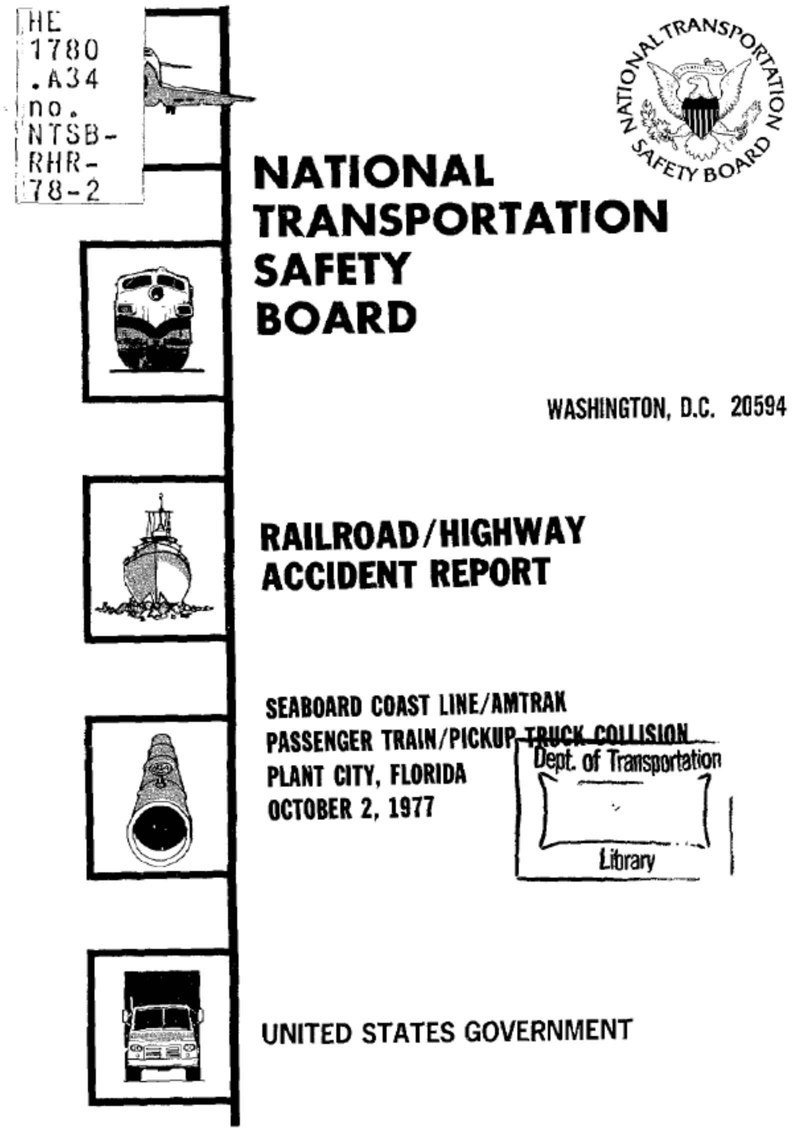
- **Pedestrians utilising Centre Rd, Bentleigh Level Crossing historically subject to excessive operation:**
  - Bentleigh is a suburban station in Melbourne. It was converted to a 3 track configuration in 1987 with pedestrian access between platforms by a pedestrian underpass or by a gate protected at grade crossing (2 tracks maximum protected by each gate pair connecting platforms)
  - The crossings in this section were known for their long operating times. I was Engineering Maintenance Manager in the early 1990's and conducted/oversaw more than one review. Findings included
    - Slow running trains due to congestion in the 3 track section on approach to junctions at each end
    - An intermittent/recurring fault which had the effect of causing large numbers of scheduled stopping trains to be signalled as express trains for the purpose of crossing operation
  - In late 1990's the pedestrian underpass was closed because of concerns about safety and flooding.
- 23 March 1998
  - During the morning peak an 18 year old lad ran across the boom gates to get a train, and didn't realise there was a train (8:01 a.m. up City Loop) coming in the opposite direction. He was hit and killed by this train. This case mirrors the scenario presented in case 2 above.
- Late1990s – one case with no incident records found.
- 18 November 2004
  - Alana Nobbs, a 15-year-old who attended a local high school got off the train and was crossing the tracks at Bentleigh Railway Station when she was hit by the city-bound
- 10 February 2011
  - The woman, aged between 40 and 50, was crossing the tracks at Centre Road around 8:45am when she was struck by the city-bound train. Police believe she was killed instantly
  - A man believed to be her husband witnessed the collision, which onlookers said happened as the pair attempted to cross the tracks while the boom gates were down
- 1 April 2014
  - A man was struck by a city-bound train near Bentleigh Railway Station at around 7.15pmhit by the city-bound train.
  - It appeared he was attempting to cross at the level crossing on Centre Road when he was hit

Level Crossing Risk Exposure

- Average Level Crossing Fatality Risk (based on pedestrian):
  - A report presented by ARRB in 1990 presents level crossing accident statistics for the period since 1975. That data shows an average pedestrian fatality rate at level crossings protected by boom barriers as approximately 1 per crossing per 25 years
- Centre Rd, Bentleigh
  - Based on the accident record for Centre Rd Bentleigh, its pedestrian fatality rate through that period was around 1 per 3 years
- Evidence of 8-fold increase in risk at crossing cf standard case
  - Multiple factors could be included in this risk
  - Other evidence is available to review

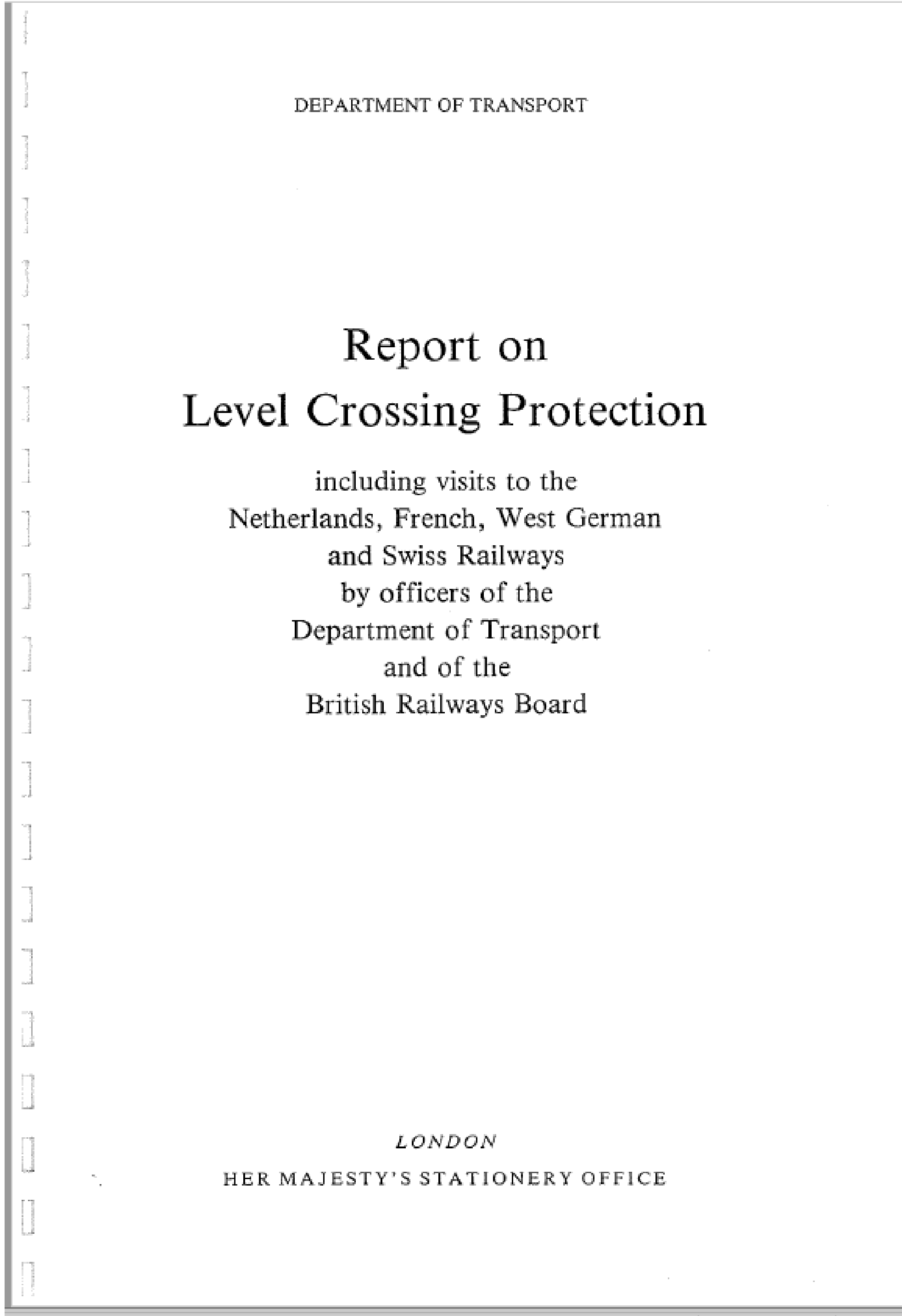
LX Case: Plant City, Florida 1977

- Amtrack passenger train collided with vehicle:
  - 10 deaths, all on road vehicle (cf 11 deaths at Hixon)
  - Flashing light protection, train speed 70mph
  - Road vehicle driver affected by alcohol
- 4 previous collisions in 6 years w 2 fatalities, 2 injuries
  - Line speed 80mph. Traffic mix – freight 20mph 90s warning (common); Amtrack 70mph, 27s warning
  - “there are many grade crossings where railroad operating conditions cause wide variation in signal warning times, false warnings, and unclear and misleading warnings. This results in motorists becoming excessively familiar with low-risk conditions that may change quickly, creating a 'booby-trap' situation.”
- Analysis of actual accidents for the line:
  - 12 times accident rate cf Amtrack expected
  - 35% improvement by providing booms would leave accident rate 8 times standard.
- Recommendation: “include provisions for uniform warning times for various train speeds in conformity with the American Association of Railroads and the Federal Highway Administration guidelines”



1978 UK Report (DoT)

- Review of Hixon Inquiry (1968) 10 years on:
  - Britain: “1 or 2 new AHBs installed per year”
  - France: 700 per year 1973 – 1975 (>8000 total)
  - Germany: 3000 AHBs in use (speeds up to 160kph)
  - Evidence that LX measures in UK had stalled
- AHBs improve safety
  - Cost Effective European Approach “adopted”
  - Some more stringent requirements from Hixon relaxed
- Standards adjusted
  - 27s warning time (back from 37s recommended at Hixon) including yellow cycle.
  - Basic pre-Hixon calculations “supported”
  - Recognition that Hixon recommendations tended to be excessive.


DEPARTMENT OF TRANSPORT

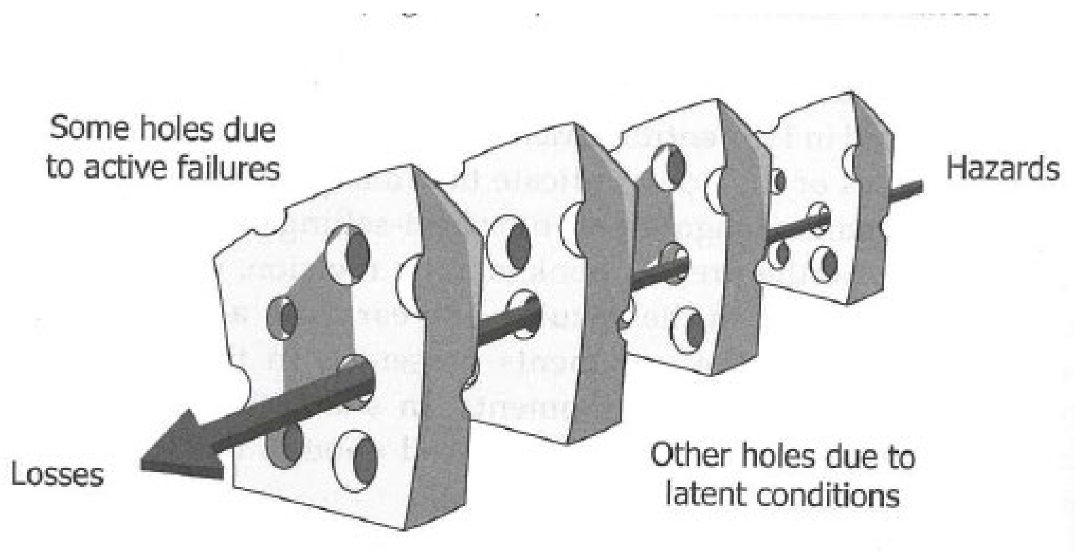
Report on
Level Crossing Protection

including visits to the
Netherlands, French, West German
and Swiss Railways
by officers of the
Department of Transport
and of the
British Railways Board

LONDON
HER MAJESTY'S STATIONERY OFFICE

Why no action to amend practice?

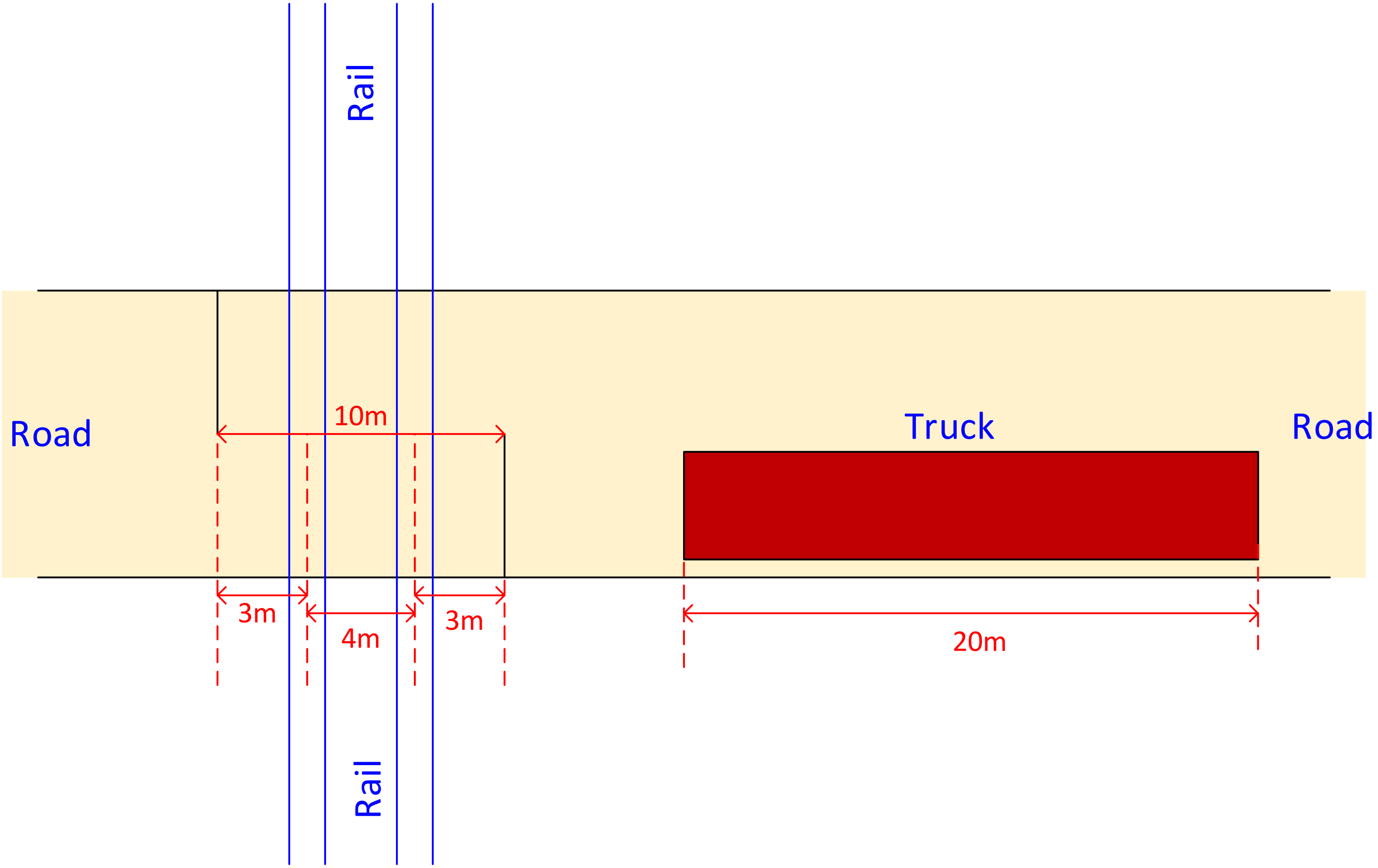
- Variant version of Reason Swiss Cheese Model
  - Rather than "risks" leading to "accidents", this variation on the model has "risks" leading to "action"
  - Barriers may include:
    - Unclear requirement
    - "Regulator has not issued instruction" (737 Max)
    - Cost not allowed (though often no cost involved)
    - Not convinced of risk ("please try to convince me" but no "engineer to engineer" contact permitted)
    - May require change to wording of standard
    - "We will fight you on this" (training for 737 Max)



- Minimum Warning Time Outcomes affected
  - "Minimum Warning" interpreted as absolute
  - "Excessive warning" clause is only optional

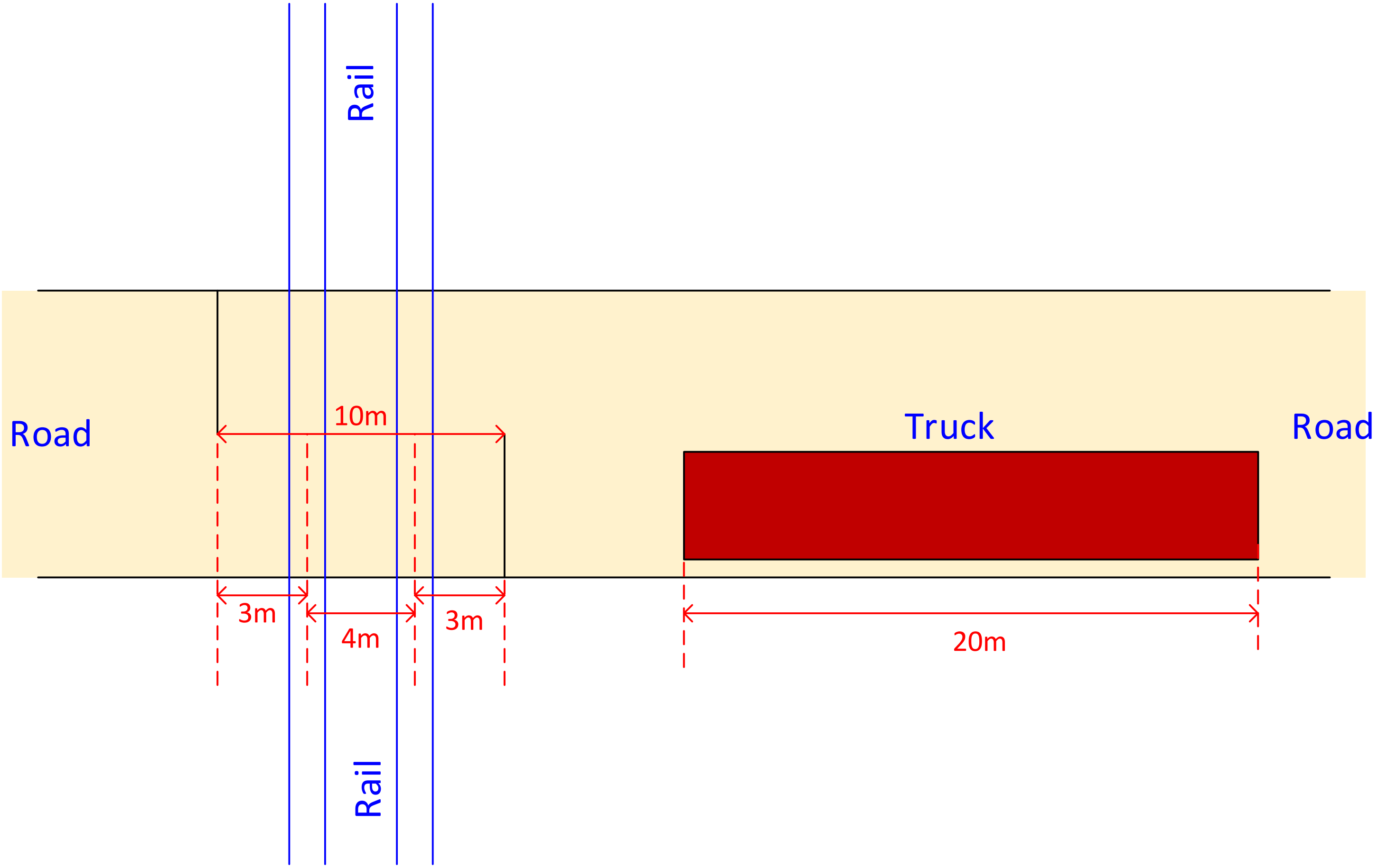
Level Crossing minimum warning

- Full Boom Sequence (UK)
  - 1s calculation time
  - 8s pre-warning
  - 8s approach barriers
  - 8s depart barriers
  - 25s total + 2s yellow
- 20s AREMA minimum
  - No depart barriers
- 25s most Aus State local minimums w 10m standard crossing
- 20s AS7658 minimum w 15m standard crossing



Engineering Basis for minimum

- Long vehicle (20m) travelling slow (3m/s) allowed for
  - 22 yards or 60 feet
  - 6mph or 10kph
  - Equivalent
- 7s for truck to pass boom
  - Pre-warning time
- 4s for truck rear to be clear of crossing
- Add engineering margin
  - 67% AREMA & AS7658
  - 100% UK (allows full closure)



Conclusion

- Providing optimum warning involves balancing the risks of inadequate warning times against the risk of the warning time being excessive. Practical design warning times must fit in the window between those two levels
- Consideration of Human Factors suggests "Shane Warne" effect significant
- We have shown:
  - Sample Mechanisms provided whereby "effect" translates to fatality
  - Risk increase (8 times) shown for Bentleigh. Mechanisms shown to be causal
  - US case (1977) and study (large crossing and fatality counts) support conclusion on 8 times risk (translates to 8 times the actual fatality count) based on use of boom barriers.
- "Other Factors" have been reviewed
  - Minimum Warning standard (most states) seen to include 100% margin for contingency based on Engineering Mechanism which causes accident.
  - No evidence of changed risk level between 20s (AREMA) and 25s (common here) minimum
- Current situation – inertia may cost lives