Scope of This Commentary

- I do not propose a full analysis of the accident here
- After performing a WBA from the information in the accident report, I raise questions concerning
  - the incomplete consideration of all possible causes of the driver's failing to slow the train
  - The adequacy of the existing protection systems, in particular for the accident location
The Brisbane-Cairns Tilt Train

The Cairns Tilt Train
A (Prototype?) Power Car

The Cairns Tilt Train

- Narrow gauge
  - 1067 mm gauge, similar to that of many streetcar systems
- Takes just over 25 hours for the 1,681 km journey
  - Previous journey time 32 hours
- „High speed“
  - 160 kph maximum speed
- Diesel
  - DMU sets: City of Cairns and City of Townsville
  - Two EMU sets also operate Brisbane-Rockhampton, which is electrified
- **Note:** the EMUs have lower C of G (CoG) than the DMUs!
The Route

Route map

Cairns
Townsville
Rockhampton
Brisbane

The Tilt Train Underway
The Tilt Train Underway

Whoops! (November 2004)
The Berajondo Derailment

What Happened, in Brief 1

• Acronym soup ahead! All that I use are defined here

• The Cairns Tilt Train (CTT) City of Townsville (CoT), a Diesel Multiple Unit (DMU), derailed at Cabbage Tree Creek (CTC) at 23:55 Australian Eastern Standard Time (EST) on 15.11.2004 between Berajondo (BO) and Baffle (BA) on the Bundaberg-to-Gladstone part of the route from Brisbane to Cairns.
What Happened, In Brief 2

- Point of Derailment (POD) was 83 m beyond the Speed Board (SPB) restricting the CTT to 60 kph. It was travelling at 112 kph at the POD.
- This 60-kph SPB was 415 m beyond the Mid-Section Magnet (MSM).
- The MSM lies 1.212 km beyond a 150-kph SPB.
- The MSM lies 3.525 km beyond the Station Protection Magnet (SPM) at BO and 3.014 km before the SPM at BA.
- On the 1.6 km stretch from the 150-kph SPB to the 60-kph SPB, the CTT had accelerated from 80 kph to 111 kph under steady power.

Derailment and Harm (people)

- The train derailed
  - close to midnight
  - dark night (no moon)
  - single-track line (as most of the way)
  - block („section“) ran between the stations BO and BA
    - Light signals at stations: in particular for entry and departure
- 0 killed; 18 severe, 10 moderate, many light, injuries
- Problems during evacuation
  - Train collided with electrification infrastructure
  - Not knowable what was „live“ and what not
Derailment Location

The Berajondo to Baffle Route Map
The Route Map Around the Derailment

The Route Map at the Point of Derailment
The Point of Derailment

- 110 km/h ‘Speed board’ before Baffle Loop
- Second 150 km/h ‘Speed board’ 420.585 km
- 60 km/h ‘Speed board’ 418.085 km

For passenger comfort, watch speed of train as will not attain max road speed [150 km/h] before braking for 90[10] km/h curve near Approach signal Baffle.

Speeds up to the POD

- 2155: 111 km/h
- 2354: 107 km/h
- 2354: 96 km/h
- 2354: 89 km/h
- 2353: 82 km/h
- 2353: 82 km/h
- 2353: 82 km/h
- 2353: 76 km/h
- 2352: 72 km/h
- 2352: 67 km/h
- 2351: 66 km/h
- 2350: 54 km/h
- 2350: 48 km/h
- 2349: 31 km/h
- 2347: 154 km/h

Point of derailment 2355:27
Speeds Immediately Before Derailment

The train was travelling at 112 kph at POD
The left-hand curve at CTC was posted for 60 kph for the Tilt Train (50 kph for others)
Tipover: full wheel unloading for lead power car of DMU at CTC would have occurred at about 97 kph
- post-accident modelling with Vampire (Sec 2.6)
Tilt Train Tips

FIGURE 1: Wheel Unloading vs Speed

The Result
An Aerial View

A Laser-Measurement Reconstruction
Selected Pertinent Facts 1

- No technical problem with train or infrastructure
- Two drivers; one had left cab to prepare coffee
  - Operationally allowed for non-driving driver to leave cab
- Signals
  - Light signals at Berajondo and Baffle stations
  - Speed boards, at which the train has already to be at or below indicated speed
- Other indicators
  - Station protection magnets at BO and BA
  - Mid-section magnet 498 m before POD
    - triggers a cab alarm which must be acknowledged, and was!
Selected Pertinent Facts 2

- One block from BO to BA
  - block occupied by the CTT at the time
- Before BO, CTT had attained 154 kph and then slowed as required
- Driver had maintained at or below posted speed up to (83 m before) POD
  - after BO, 74 kph → 58 kph → 111 kph
  - After BO SPM, 72 kph → 111 kph
  - After 150-kph speed board, 80+ kph → 111 kph
    - Note: train is physically unable to attain 150 kph in this short 1.627-km segment before the CTC 60-kph speed board
  - did not slow at MSM
Causes?

- Pretty clear: cause was derailment at excessive speed (Report Sec 2.8, 3.1 Major Factor 1)
- That means, in the absence of automatic protection systems, that for better or for worse the driver is causally implicated
- So what on earth was going on?
  - We shall consider this after seeing the WBG
Report Conclusions: Major Factors

- 1. Accident principally caused by excessive speed
- 2. The driver did not reduce the train to a safe speed before entering the Cabbage Tree Creek curve
- 3. The train was in steady power „virtually up to“ derailment [PBL note: to 3 secs before derailment]
- 4. It is possible that the driver became disoriented and/or distracted from his principal task in this section
- 5. There is no technical system that detects very short periods of driver inactivity/distraction

Report Conclusions: Underlying Factors 1

- 1. At 417.783 km (23:54.26 hours), posted speed increases to 150 kph
- 2. Possible that driver mistook mid-section alarm for station protection magnet before Baffle
- 3. Possible that driver momentarily left driving position, either shortly before or after passing mid-section magnet
Report Conclusions: Underlying Factors 2

- 4. Safe driving of CTT largely depended on:
  - driver responding to external prompts
  - speed boards, vigilance-system warnings, station magnet system
  - driver's track knowledge and competency
  - two-driver mode of operation
- 5. Co-driver absent from his seat, not in a position to check driver’s ops (operational procedures did not preclude this)
- 6. Train's headlight would only have provided limited visual detail (of distant SPB or CTC curve)

Report Conclusions: Underlying Factors 3

- 7. External darkness may have contributed to loss of geographical awareness
- 8. MSM is primarily used for providing tilt train geographical reference information. It provides no indication of location or next speed limit. A driver who incorrectly assumes the location of the train is not aided by the alarm.
- 9. [Monitoring of driver's return to duties after absence]
The Why-Because Graph
Observations on the WBG

- The WBG is sparse
  - 23 nodes altogether, 18 nodes precursory to derailment
- However, it does identify significant issues
  - Track design: 5 out-edges!
    - Design of curve (general topography of track in vicinity)
    - 1.627 km segment posted 150 kph followed by posted-60-kph curve
    - MSM 0.415 km before 60-kph SPB
  - Few sensory clues to position
    - SPB and MSM
    - Moonless night. Headlights inadequate?
  - Train
    - accelerated continuously for 4+ km previous to POD
    - braked 2-3 sec before derailment (driver saw 60-kph SPB?)
General Observations

- Note that this WBG is derived from the report
  - It was not produced through our interpretation of events
- It identifies significant issues
  - Explaining why driver accelerated and failed to slow
    - Acceleration? Obvious: he could accelerate while remaining under posted limits, so why not?
    - Failing to slow? Not so obvious
  - Design of protection systems: adequate?

Observations and Partial Analysis
Two Main Issues from WBG

1. Why did driver fail to slow?

2. Are the protection systems adequate?

Disclaimer

- Please note: in what follows, I am deriving individual factors
- These factors are not to be thought of as mutually exclusive. It is possible, even likely, that, of the potential factors I identify, more than one of them played a role in the accident
- My purpose in Issue 1 is to enumerate potential factors, and note how (whether) they are handled in the accident report; it is not to propose my own explanation of the accident
- My purpose in Issue 2 is to assess countermeasures
Issue 1: Driver Failed to Slow

Potential Causes of Failing to Slow 1

- Driver distracted, fatigued or incapacitated?
  - Distracted? Maybe (maybe left his seat, Sec 2.8)
  - Fatigued? Probably not (Sec 2.12)
  - Mentally or physically incapacitated? Probably not (Secs 2.8, 2.13)

- Driver mistook geographic position of train?
  - Thought he was in different block? Not addressed
  - Thought he was further along the block? „Real possibility“ (Sec 2.8)

- Driver wasn’t aware of impending sharp curve
  - misread/misremembered Route Map? Not addressed
  - ... or lapsed in understanding route? Not addressed
  - ... or left his driving position and missed cues? Possibly (Sec 2.8, also Conclusions 3.2: Underlying Factors 3)
Potential Causes of Failing to Slow 2

- Driver intentionally caused derailment
  - No evidence (Sec 2.8)
- Driver intentionally driving fast
  - .... and misjudged braking? „Unlikely“ (Sec 2.8)
  - .... and misjudged stability? **Not addressed**
    - Note: DMU has higher CoG than EMU and he drove both
    - Note: He has no other traffic to worry about, just the track geometry

Potential Causes Not Addressed by Report

- Driver mistook geographic position of train?
  - Thought he was in different block?
  - Thought he was further along the block? **Partially addressed only**
- Driver wasn’t aware of impending sharp curve
  - misread/misremembered Route Map?
  - ... and lapsed in understanding route?
- Driver intentionally driving fast
  - .... and misjudged stability?
Mistook Geographic Position 1

- Did he mistake the block and think he was somewhere else than between BO and BA?
  - Signals at BO clearly marked „BO xy“, where x and y are each decimal digits
  - Signal marker boards „very visible“
  - With two drivers in cab, driver driving must call out signal ID when passing and driver not driving must confirm
  - One could conclude it is unlikely that the driver mistook the block he was in
  - Nevertheless, this issue is not addressed in the report: an incompleteness

Mistook Geographic Position: At BA SPM? 1

- Did he think he was at BA SPM, just before the 110-kph-posted curve? A „real possibility“ (Sec 2.8, also Conclusions: 3.2 Underlying Factor 2)
- Consider the facts about the route ..................
Mistook Geographic Position: At BA SPM? 2

- The train had passed no sharp curve after BO
- He would have sensed CTC curve, had CTT traversed it
  - The power car, where the driver is, does not tilt
- The magnet sequence
  - MSM is 2nd magnet after BO
  - BA SPM is 3rd magnet after BO
  - MSM is about 3.5 km from BO SPM
  - BA SPM is about 6.5 km from BO SPM
  - He was only 2.5 minutes from BO SPM
  - BA SPM is somewhere between 4-5 minutes from BO SPM
- The „freedom“ sequence
  - 150-kph SPB gives the driver freedom to full-throttle
  - There are two „freedom“ segments: one before CTC and one after
  - He'd opened up the throttle just once

Mistook Geographic Position: At BA SPM? 3

- In order for this „real possibility“ to have occurred inadvertently, the driver would have had to
  - err in counting magnet alarms
  - err in counting his „freedoms“
  - mistake his 2.5-minute journey since BO SPM for a 4-5-minute period
  - be unaware that he had not sensed the sharp curve at CTC
  - be unaware of his speed profile since BO SPM of having maintained a speed at least 12 kph above that allowed at CTC
  - be unaware of having accelerated continuously under „steady power“ for over 4 km, since the shunt limits/75-kph speed board at BO
- In my judgement, that would constitute a „lapse in concentration“ of significant proportions
- One might well consider it to show cognitive impairment
Mistook Geographic Position: At BA SPM? 4

- So this "real possibility" implies a multitude of significant lapses, to an extraordinarily high degree.
- But the report considers the driver to have been in possession of the appropriate cognitive faculties (Secs 2.8, 2.12, 2.13 as noted).
- So it looks to this reader as though the report almost contradicts itself.
  - One cannot speak of a literal contradiction here: these issues concern degrees to which cognitive properties manifest. Better to say high tension?
  - That leads us to consider dissolving the high tension.

Resolving/Dissolving the High Tension 1

- One horn
  - The driver suffered a close series of significant cognitive lapses, both continual and punctual, over a period of three minutes or more.
  - Neither the "soft" protection systems (two-driver ops, speed boards, route knowledge and maps) nor the "hard" protection system (BO SPM, MSM) sufficed to intrude into cognition.
- Conclusion
  - The design of the protection systems on the route do not take into account the possibility of such significant lapses.
  - If one concludes that they did occur, protection systems must be adapted.
Resolving/Dissolving the High Tension 2

- The other horn
  - Assume that the driver was indeed in possession at the time of appropriate cognitive faculties (such that a significant ongoing series of lapses likely did not occur)
  - Then he was aware that he was traversing/had traversed a section including a 60-kph restriction at speeds high (indeed, much higher) than 72 kph
  - That is, he was and had been prepared to bust speed limits where he thought it appropriate
  - The report does not address this possibility: another incompleteness in the report

Observations 1

- Observe that deliberate violation of the speed limit would be enough by itself to explain the accident
- Note that I am not making the suggestion that this did happen
  - I am not a policeman; I am not an investigator; I am not a lawyer; I am not expert in the sociology of railwaymen in Australia; <insert appropriate additional disclaimers>
  - I am saying that a comprehensive analysis would address it; and that the report didn't do so
Observations 2

• But is this horn of the high tension at all plausible?
  
  
  • Interpretation of Practical Drift theory here:
    
    • Tensions between organisational goals ....
      
      • Prestigious „high-speed“ service
      
      • Safety requires low speeds at many points
      
      • ..... lead to dynamic adaptations of procedures and behavior
      
      • „Speeding“ by drivers where it is considered to be doable

Observations 3

• The phenomenon whereby agents adapt behavior and procedures to resolve tensions in organisational goals (whether one calls it „practical drift“ or not) is widely recognised

• Some examples
  
  • „Get-home-itis“: corporate aircraft crews under pressure to take the boss where heshe wants, when heshe wants
    
    • Corporate aviation is significantly more susceptible to weather-related accidents than commercial aviation
  
  • Commercial aircraft crews under pressure to maintain schedule and destination
    
    • Landing at the goal airport, near to time, while conserving fuel
Observations 4

- An example closer to „home“:
  - December 1999 Glenbrook, NSW, rail accident
  - Analysed by Andrew Hopkins (Chs. 2-7 of *Safety, Culture and Risk*, CCH Australia, Sydney, NSW, 2005)
    - Commuter train passed a signal at „halt“...
    - ... after obtaining permission from signaller to do so...
    - ... after signaller indicated informally that track was clear...
    - ... commuter train driver accelerated ....
    - ... and ran into the rear of the *Indian Pacific* cross-country train that had been waiting at the next (halt) signal while obtaining permission to proceed
  - Hopkins discusses cultural tensions and adaptations to those tensions within NSW rail operations

Observations 5

- Besides ... dare I say this? ... isn't it sometimes just fun to exercise the capabilities of well-designed high-tech equipment?
- Possibly c.f. 1988 Airbus A320, Habsheim, France?
  - Air France pilot attempted to perform „standard“ Airbus airshow-pilot manoeuvre – steep climb-out from low-energy low pass
  - Without having experience with the manoeuvre
  - Without having scoped the airshow airport
  - Without having fulfilled the legal requirements for approval
  - With a plane load of uninformed passengers (illegal!)
  - From/in an unstabilised approach and unstable/unplanned state
  - With far too low engine speed („idle“ power instead of 60% N1)
Observations 6

• The report suggests that the scenario in which the driver was intentionally driving "to the limit" and misjudged braking is "unlikely" (Sec 2.8)

• However, that he misjudged his braking is fact:
  • He applied full brakes 2-3 seconds before derailment
  • That suggests that he felt he needed emergency brakes
  • Full braking is not comfortable for (sleeping?) passengers
  • As far as anyone knows, there was no obstacle on the track to cause such a brake application
  • The full braking occurred at or near the CTC speed board

• Given the previous observations, one wonders which part of this scenario renders it "unlikely", and how?

Unawareness of Impending Curve

• Such unawareness would imply that
  • either the driver was operating under significant cognitive impediment (ruled out: Secs 2.8, 2.13)
  • ... or he overlooked the CTC speed restriction on the Route Map (either through misattention or through not using the Route Map) and had forgotten about it (misapplied his route knowledge)
  • This second potential factor is not considered in the report: an incompleteness
  • Note that such a phenomenon has been seen already in the first horn of the high tension
Intentional Speeding

- Considered already as the second horn of the high tension
  - Reminder: the report does not consider it. This constitutes an incompleteness in the report

Failing to Slow: Summary

- The report considers some, but not all, of the causal possibilities of the driver failing adequately to slow
- The causal possibilities that it fails to consider are
  - Mistaking the block
  - Consequences of the scenario of thinking to be at BA-SPM
    - Significant cognitive lapses continuously for over 3 minutes, or
    - Intentionally speeding (or being prepared to do so)
    - Consideration of this scenario calls into question the judgement that scenario of „driving to the limit“ and misjudging braking „unlikely“
  - Unaware of curve/Misapplying Route Map/Knowledge
    - Scenario has much in common with above and analysis is similar
  - Intentional „speeding“
    - ... for understandable, indeed well-studied, sorts of reasons
    - Scenario also considered in above analysis
Existing Protection Systems

- Route Knowledge & Maps
- Station-protection/mid-section magnets
- Speed boards
- Two drivers
Protection Systems 1: Route Knowledge

- Although route knowledge and competence is trained, training is regarded across many industries as insufficient to eliminate procedural errors fully
  - e.g., see comments above on why driver failed to slow
- Indeed, it may encourage them!
  - Intimate route knowledge may lead to overconfidence in the capabilities of the kit
  - Intimacy with operations may lead to violations of defined procedure
    - particularly to increase "efficiency" or ameliorate tensions
    - again, as in Snook's Theory of Practical Drift

Protection Systems 2: Warning Magnets

- Positional warning systems of this simple kind are present on most railway systems in the developed world
- They give point-based, relative-positional information, and rely on a driver knowing within the resolution distance (less than or equal to one block) where he/she is
  - The mid-section magnet apparently did not suffice in this case to warn the driver that he needed to reduce speed
    - (something else did, 13-14 seconds later)
Protection Systems 3: Speed Boards

- These are speed-limiting signs, not advance warnings of speed restriction
  - They advise a driver of the current speed limit
  - They do not suffice to warn a driver sufficiently in advance to reduce speed

Protection Systems 4: Two Drivers

- In aviation (Pilot Flying and Pilot Not Flying) two operators can function as a team
  - there are flying tasks and non-flying tasks to perform
  - However, there are few non-driving operational tasks in the cab besides supervision – it is mostly “single driver”
  - Such so-called „supervisory control“ is not always effective
    - This is well-known: see work of Thomas B. Sheridan
    - In air traffic control, supervision has been shown to be helpful
    - In other domains, a „group think“ effect, whereby both parties tend to make the same mistaken assumptions about a state of their operation, can be/is often present (see especially Snook, op. cit., concerning both the pilot-wingman team and the AWACS team)
    - It is not (yet) known in rail operations which mode dominates
Signalling Systems

- Light signals at stations
- Speed boards
- Station markers
  - station signals have reflective nameplates with unique ID
    - station unique-ID: Berajondo is BO; Baffle is BA
    - 2-digit number
  - readable from the cab
  - 2-driver ops requires call-out/confirmation when passing
    - ... when there are two drivers in the cab
- (Milestones? There, but not signals
  - reflective kilometer markers, but positioned away from the track and do not normally act as cues for the driver)

Existing Protection Systems: Analysis

- Had the driver
  - been aware that he was between BO and BA
  - correlated the MSM alarm with the Route Map and the time as well as his route knowledge
- .... then the MSM might have sufficed to allow sufficient speed reduction ....
  - ..... in the accident case (from 111 kph down to say 90 kph)
  - ..... but not in regular operations (from say 120 kph down to 60 kph)
  - ..... and not theoretically (from 150 kph down to 60 kph)
- Proof follows
Braking from Mid-Section Magnet 1

- The dynamics of braking is as follows
  - Distance mid-section magnet to speed board = 415 m
  - \[ S = v_0 t + \frac{1}{2} a t^2 = \frac{(v^2 - v_0^2)}{2a} \]
  - \( @ a = 1 \text{ m/s}^2, v_0 = 150 \text{ kph}/\sim 42 \text{ m/s}, v = 60 \text{ kph}/\sim 17 \text{ m/s} \)
    - braking distance = 738 m + reaction distance
  - \( @ a = 1 \text{ m/s}^2, v_0 = 120 \text{ kph}/\sim 33 \text{ m/s}, v = 60 \text{ kph}/\sim 17 \text{ m/s} \)
    - braking distance = 400 m
    - reaction time = 2 s
    - reaction distance = 2 s x 33 m/s = 66 m
    - total distance from magnet to 60 kph = 466 m

Braking from Mid-Section Magnet 2

- For the existing situation:
  - \( @ a = 1 \text{ m/s}^2, v_0 = 111 \text{ kph}/\sim 31 \text{ m/s}, v = 90 \text{ kph}/25 \text{ m/s} \)
    - braking distance = 168 m
    - reaction time = 2 s
    - reaction distance = 2 s x 31 m/s = 62 m
    - total distance from magnet to 90 kph = 230 m

- Conclusion: the driver could have slowed the DMU sufficiently to round the CTC curve without derailing, had he
  - had appropriate positional awareness
  - reacted with braking to the mid-section magnet alarm
- But this is not practical for the design of regular operations
  - exact wheel unloading dynamics not known beforehand
Braking from Mid-Section Magnet 3

- Deceleration of 1 m/s² is emergency braking
  - Normal braking on, say, the German railway is 0.5 m/s
- At normal braking (0.5 m/s²), the figures are
  - @ $a = 0.5 \, \text{m/s}^2$, $v_0 = 150 \, \text{kph}/\sim 42 \, \text{m/s}$, $v = 60 \, \text{kph}/\sim 17 \, \text{m/s}$
    - braking distance = 1,476 m + reaction distance
  - @ $a = 0.5 \, \text{m/s}^2$, $v_0 = 120 \, \text{kph}/\sim 33 \, \text{m/s}$, $v = 60 \, \text{kph}/\sim 17 \, \text{m/s}$
    - total distance from magnet to 90 kph = 866 m
  - @ $a = 0.5 \, \text{m/s}^2$, $v_0 = 111 \, \text{kph}/\sim 31 \, \text{m/s}$, $v = 90 \, \text{kph}/\sim 25 \, \text{m/s}$
    - total distance from magnet to 90 kph = 398 m

- Normal braking would barely have sufficed!

Braking from Mid-Section Magnet 3

- Conclusion: the mid-section magnet does not suffice to give appropriate operational indication of the approaching speed restriction to 60 kph
- It follows that, in absence of visual clues (this section is always passed at close to midnight by the CTT),
  - either route knowledge plus dead reckoning
  - or a preparatory speed restriction to below 120 kph, in anticipation of further slowing at the MSM
- ... is necessary to achieve the required 60 kph by the CTC SPB
Protections: Summary 1

- Route knowledge + dead reckoning is not reliable to the degree required to avoid all possible procedural errors over the operational life of the CTT
  - equally whether there is a driver team or single driver
  - This human phenomenon is unavoidable
- The speed restriction preparatory to CTC SPB is procedurally ineffective
  - Note this is consistent with intent: speed boards are not intended to guide operations, but to restrict them
  - Either there needs to be an appropriate speed restriction
  - .... or additional reliable protection mechanisms need to be installed at this point

Protections: Summary 2

- Note that no „soft“ protection (for example, an advance speed restriction, or an advance warning board) would suffice to preclude intentional speeding
- Only a „hard“ protection (ATP, say at an advance speed warning board and again at the MSM) would suffice rigorously to preclude deliberate speeding
- A „firm“ protection - say, data logging and post-trip evaluation - might help (see next slide)
„Firm“ Protection

- It may be that those drivers who might have been tempted to drive faster than posted have now been discouraged from traversing CTC at greater than, say, 90 kph :-)
  - Might one consider this cultural feature a form of „firm protection“?
    Or is it still „soft“?
- A driving operational-quality assurance program (DOQA) based on full-journey data loggers and (semi-automated) evaluations of each journey might suffice to identify common procedural infelicities (without needing to distinguish between inadvertent and deliberate actions)
  - FOQA (Flight Operational Quality Assurance) is proving its worth for many airlines, including Qantas I believe
  - There is now significant experience with FOQA which could be adapted to rail operations

Conclusion of Protection-System Analysis

- Additional protective mechanisms are required at (at least) CTC to ensure that normal operations can be pursued in darkness
  - even with a speed reduction to 110 kph over this segment
  - with normal braking performance
  - with adherence to all posted speeds
- Possible such mechanisms include
  - advance speed restriction at CTC
  - advance speed warning boards
  - ATP
  - a DOQA program
Protection Systems: Comment

- The analysis has concluded that the existing protection systems cannot have sufficed to ensure that the Cabbage Tree Creek curve would be successfully rounded under all foreseeable circumstances
  - This raises questions for the scope and conclusions of the „comprehensive risk assessment“ and „fully documented safety case“ which established that this line was „suitable for tilt train operations“ (QT/ATSB Report Sec 2.2)
  - One obvious response: of course the line was suitable, in the sense that one can just travel according to whatever procedures maintain the required safety level!
    - But what exactly were/are those procedures?

Conclusions

- This work
  - has performed a WBA of the Berajondo derailment
  - ... and has analysed therefrom the major causal factors identified by the WBA:
    - Possible causes of the driver’s failing to slow
    - Adequacy of overspeed protection systems
  - ... and has concluded that
    - the consideration in the accident report of the possible causes of the driver’s failing to slow is incomplete
    - the overspeed protection systems in the vicinity of Cabbage Tree Creek are inadequate

- It demonstrates once again the value of performing a WBA
Acknowledgements

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The End

Thanks for listening!