Railway equipment
- Adapting to climate change

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Agenda

1. **Rolling Stock**
2. Infrastructure
3. Process
4. Conclusions

Rolling stock issues – reliability, availability & safety

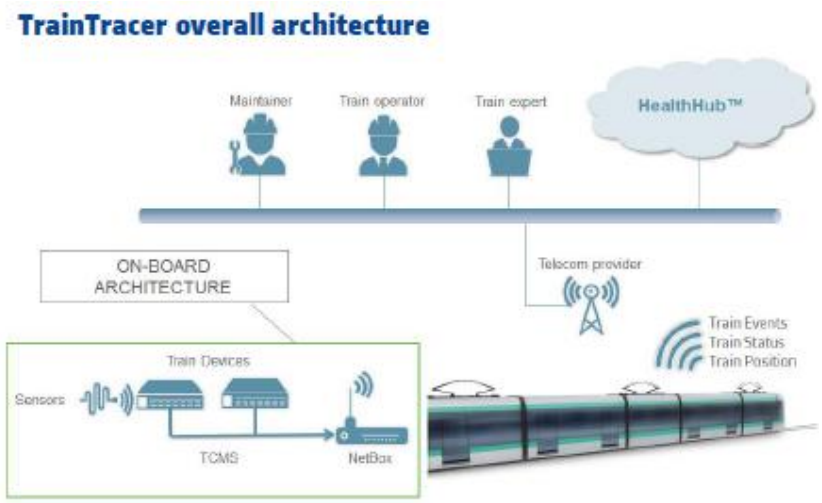
- High temperatures
- Sand and dust
- Humidity and salt
- Strong winds
- Big weather variations

Adaptation of Rolling Stock to extreme conditions

- **Resizing of the electric and the electronic equipment**
  - Temperature of functioning of the standardized interface equipment
  - Cooling of the power supply system, power converter, engine
- **Protection of electronic control panels**
- **Sanding equipment**
  - Cyclonic filters, blades, bellows
  - Roof air supply
- **Reinforcement of thermal isolation (car shell, windows)**
- **Reinforcement of the air-conditioning system**
- **Installation of window-blinds**
- **Condensation protection**
- **Management of air-flow**

Adaptation of Rolling Stock to extreme conditions: Traintracer

- **Real-Time** condition monitoring – understanding the health of a train at any moment and the trends
- Turning railway data into **meaningful information** for operators and maintainers
- Supporting **predictive** maintenance
- Optimising **fleet management**
- **Anticipating** train movements and **troubleshooting**



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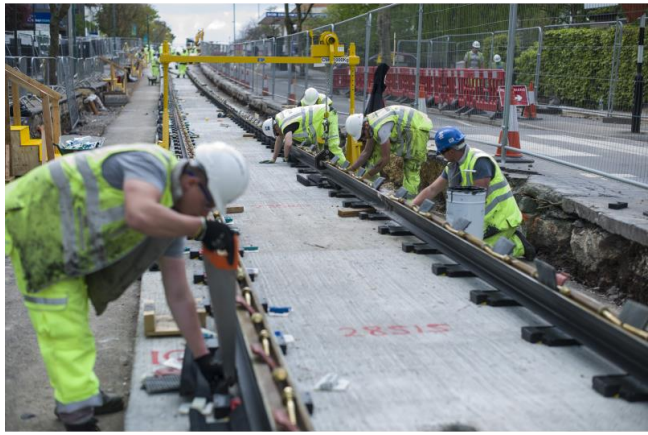
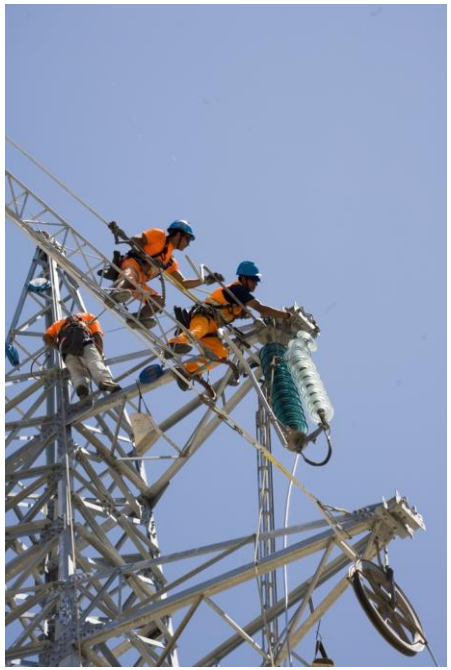
Infrastructure issues & solutions: Track

- Desert conditions – sand in the ballast
  - Add vegetation; fencing
  - Use of slab track
- Track buckling
  - Rail expansion joints and fastenings
  - UV testing
  - Composite materials
- Urban track
  - Concrete durability
  - Reinforcement
  - Depth of concrete layer
  - Flooding
- Tracktracer
  - To monitor the state of the track in real time



Infrastructure issues & solutions: Electrification

- Sand storms
  - Sand eats catenary and pantograph pads
  - Enhanced filters against sand/dust
- Heat
  - Redundant systems e.g. back-up cooling systems
- On board cameras
  - To monitor the state of the catenary



Infrastructure issues & solutions: Signalling systems

- Very little track-side equipment with the latest technologies
  - Balises; point machines; some lights
- Need to protect electrical cables
  - Composites
  - Troughs
  - UV tested
- Electronics
  - Redundancy built-in
  - Maintenance is reactive
- Remote health monitoring (ex: point machines)
  - Monitor current needed to move the rail over time
  - Alert mechanism

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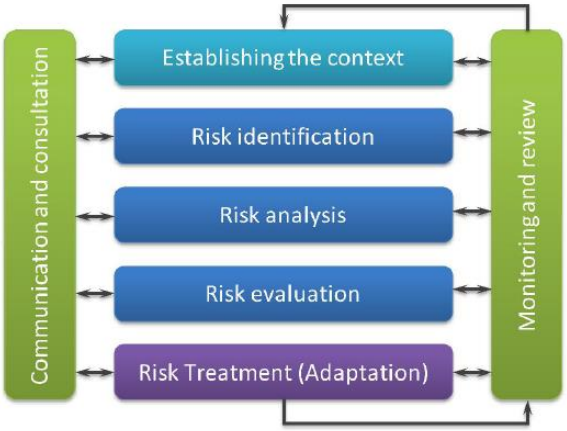
Climate Change Impact Assessments and Adaptation reports

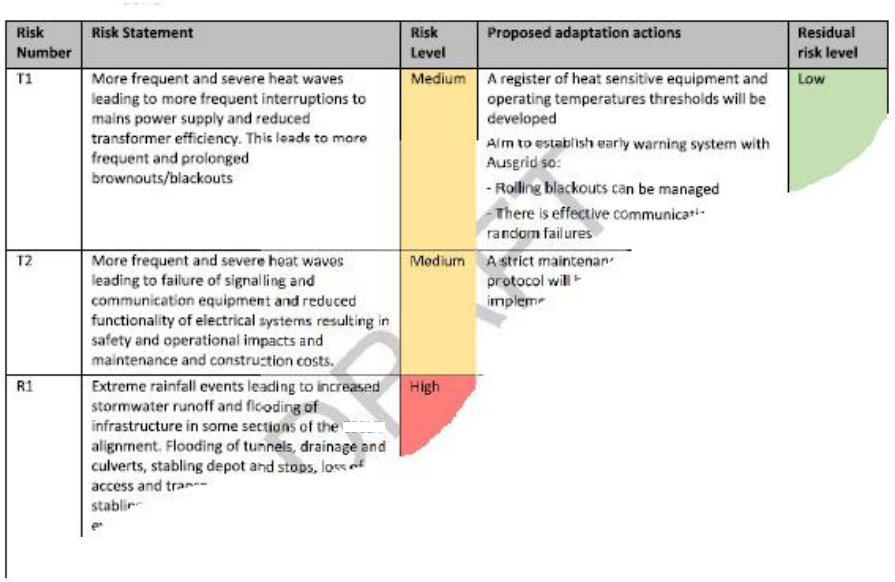
The start of a trend in railway system procurement

- Identification of project-specific climate change risks
- Identification of risk mitigation measures
- Outlining how risk mitigation will be addressed through the design process to reduce risks to “low” where practicable



Climate Change Impact Assessments and Adaptation reports

- Assessing primary risks specific to a project/alignment e.g.
  - Temperature: incl. increase in annual average temperature and heatwaves
  - Rainfall: reduction in annual average rainfall, increase in extreme rainfall events and associated flooding
  - Storm events: including hail, lightning and severe winds
  - Sea level rise and storm surge
  - Other impacts: e.g. increased CO_2 in the atmosphere and increased solar radiation
- Assessing current controls
- Proposing adaptation actions



Risk Number	Risk Statement	Risk Level	Proposed adaptation actions	Residual risk level
T1	More frequent and severe heat waves leading to more frequent interruptions to mains power supply and reduced transformer efficiency. This leads to more frequent and prolonged brownouts/blackouts	Medium	A register of heat sensitive equipment and operating temperatures thresholds will be developed Aim to establish early warning system with Ausgrid so: - Rolling blackouts can be managed - There is effective communicati random failures	Low
T2	More frequent and severe heat waves leading to failure of signalling and communication equipment and reduced functionality of electrical systems resulting in safety and operational impacts and maintenance and construction costs.	Medium	A strict maintenan protocol will b impleme	
R1	Extreme rainfall events leading to increased stormwater runoff and flooding of infrastructure in some sections of the alignment. Flooding of tunnels, drainage and culverts, stabling depot and stops, loss of access and trans stablin e	High		

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Conclusions

- We need to design for an increased frequency of extreme events
- Tell us what conditions you need us to design for and we will do it
- Important to monitor the health of key equipment – to predict issues
- Careful planning needed to ensure rapid restoration of service after extreme climatic events
- Extreme conditions represent constraints and cost but we already have a portfolio of proven solutions

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