AUSTRIA VIENNA 2024 IRSC INTERNATIONAL Railway Safety Council

Enhancing Railway Tunnel Safety
A Journey Through Innovation and Experience

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Lessons from Eurotunnel and Beyond

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Vienna, Austria
Aula der Wissenschaften

A stitch in time may save nine - Thomas Fuller

Only dull people are brilliant at breakfast - Oscar Wilde

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Implementing an Integrated Approach to Tunnel Safety

1. Acting on Lessons Learnt

Leveraging experience from Eurotunnel and other rail systems, we can manage safety better and contribute to incident prevention.

2. Collaborative Approach

Engineers, regulatory bodies, and operators should work together to ensure safety enhancements are effectively implemented.

3. Innovation in Safety

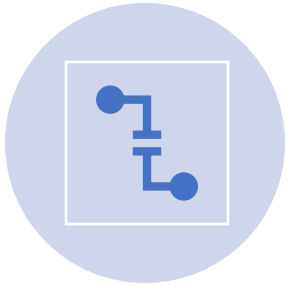
Focusing on innovation and operational experience can enhance tunnel fire safety management and reduce risks in proportionate ways.

Summary

1. By learning from and acting on operational experience, we can collectively help reduce the likelihood of future incidents.

2. This requires collaboration between engineers, regulatory bodies, and operators to ensure that safety enhancements are implemented effectively without compromising operational efficiency.

3. By focusing on these and on innovation, we will enhance tunnel safety management and reduce the risk of catastrophic incidents over next decades.



4. For the Channel Tunnel, achieving this has enhanced our safety and resilience, ensuring that it remains the safest and most reliable link between the UK and France.

Eurotunnel Context - A Unique Challenge

Engineering Marvel

Eurotunnel is a remarkable engineering feat connecting the UK and France via the world's longest undersea tunnel.

Operational Complexity

With over 200 km of tracks and a dedicated service tunnel, managing such a vast infrastructure presents unique challenges.

Safety Focus

Eurotunnel prioritizes safety, evident in its advanced fire detection systems and robust emergency response plans.

Trade Link Significance

The Channel Tunnel's crucial role in trade and its historical milestones underscore the need to maintain safety and reliability.

Steve Demetriou, Channel Tunnel Safety Authority, IRSC, Paris, October 2016: *Developing New Evacuation Procedures for the Channel Tunnel, Steve Demetriou, Channel Tunnel Safety Authority.*

UK-French Binational Legislation Landscape

1. Regulatory Framework

The Channel Tunnel operates within a unique binational regulatory framework, overseen by the Intergovernmental Commission (IGC) and the Channel Tunnel Safety Authority (CTSA).

2. Shared Responsibilities

The IGC and CTSA collaborate to ensure compliance with both UK and French regulations, addressing challenges and opportunities presented by this binational framework.

3. Cooperation & Information Sharing

Effective regulatory cooperation and information sharing between UK and French authorities are crucial for maintaining high safety standards and addressing emerging challenges.

4. Enhancing Tunnel Operations

By fostering a collaborative regulatory environment, we can optimize tunnel operations, ensuring the safety and efficiency of this vital infrastructure.

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Complex Environment and Risk Landscape

Uncertain Fire Dynamics: Tunnel fire safety assessment faces significant challenges due to the complex and unpredictable nature of fire behaviour in behaviour in enclosed environments.

Limited Data Availability: The lack of comprehensive data on tunnel fires hinders the development of accurate models, leading to potential oversimplification and less precise predictions.

Evacuation Behaviour Uncertainty: Predicting human behaviour during evacuations is challenging due to data on how people respond in such situations.

Technology Integration: While advanced technologies, such as networks and AI, offer potential for enhancing safety, their integration tunnel fire safety management its early stages.

Major Fire Incidents and Safety Improvements

11 September 2008 Fire

A Eurotunnel Shuttle train carrying heavy goods vehicles caught fire, lasting 16 hours and reaching 1,000°C. Fortunately, there were no fatalities but 14 people suffered minor injuries.

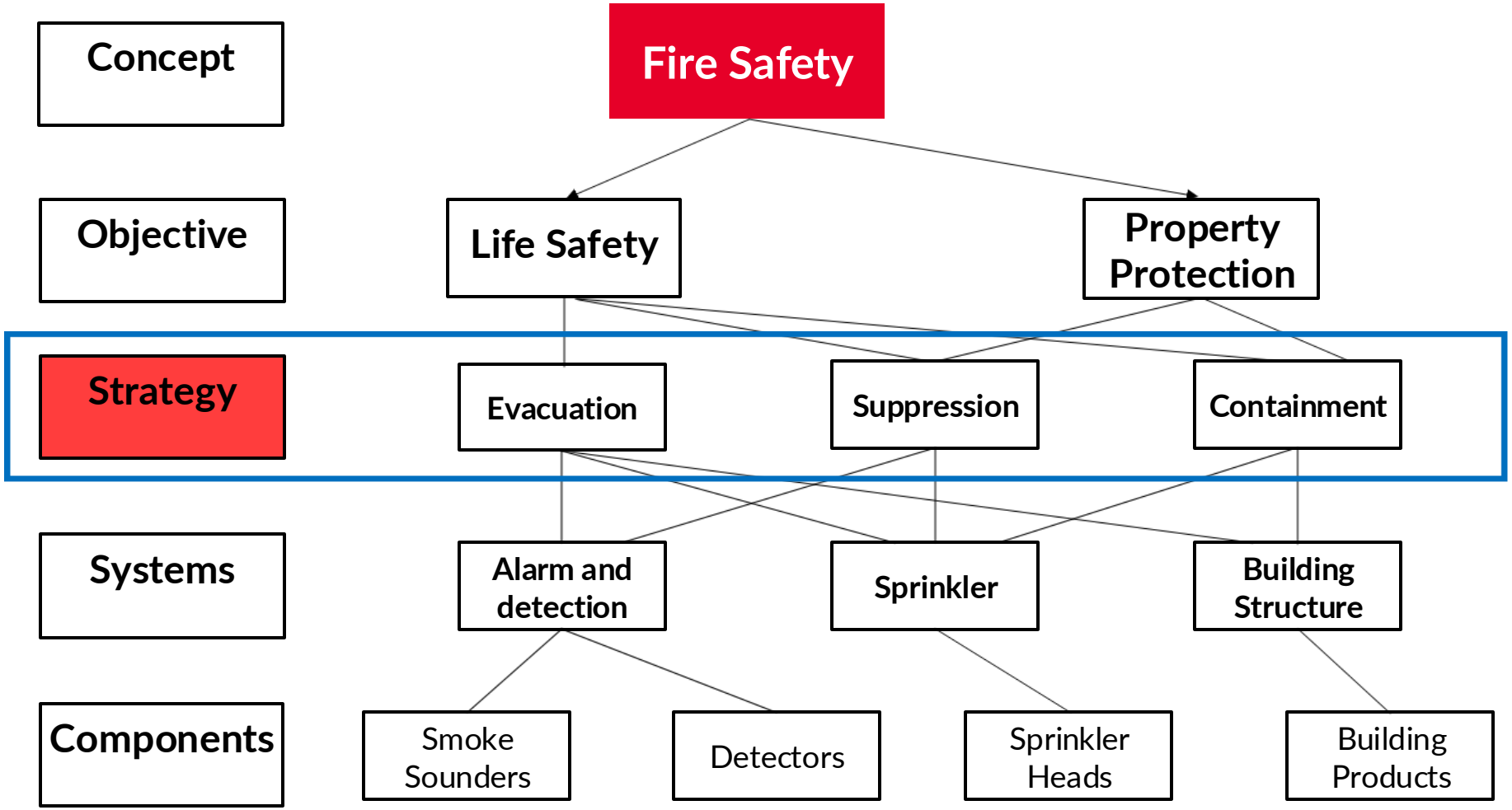
Safety Enhancements

Eurotunnel revised its safety protocols, including fire detection systems, firefighting equipment, and emergency response team training.

Prioritising Learning

Past incidents, including fires in 1996 and 2015, have prompted continuous safety improvements to prevent future occurrences.

Example of a Tunnel Fire Safety Strategy



A Proactive, Data-driven Approach to Risk Management

Regular risk reviews and a comprehensive risk management framework are essential for ensuring the safety of railway tunnels.

We use risk assessment tools, such as Bow-tie analysis and risk modelling to identify potential failures and their consequences. We integrate qualitative and quantitative risk assessment methods to inform decision-making.

Our Safety Risk Model will allow us to quantify collective risk and prioritize mitigation strategies. This model helps us systematically assess hazardous events, understand potential impacts, and implement targeted risk controls.

Leveraging technology, such as data analytics and modelling techniques, enables us to identify trends, estimate risks, and optimize safety performance.

Fire modelling and simulation play a crucial role in optimising safety measures, ensuring that we remain at the forefront of tunnel safety innovation.

Safety by Design

1. Key Safety by Design Principles

Proactively incorporate safety features into the design and construction of the railway system to mitigate risks and enhance resilience in case of emergencies.

2. Collaboration and Innovation

Eurotunnel collaborates with designers, operators, and safety experts to continually explore and implement innovative technologies, such as digital twins and firefighting robots, to enhance safety.

3. Safety by Design Features in Eurotunnel

Eurotunnel employs a comprehensive suite of safety by design features, including fire-resistant materials, advanced ventilation, and early warning systems, to ensure the safety of passengers and staff.

4. Continuous Improvement

Eurotunnel continually evaluates and improves safety by design features based on lessons learned from incident investigations and technological advancements.

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Innovative Solutions

1. Advances in Smoke Management

High-performance computing and computational fluid dynamics are revolutionizing tunnel safety.

2. Intelligent Monitoring Systems

Water mist systems and smoke extraction shafts are innovative solutions being implemented.

3. Challenges

Integrating these technologies into existing tunnels presents challenges, including structural limitations and financial constraints.

4. Addressing Challenges

Careful planning and coordination are required to address these challenges.

Conclusions and Call to Action

1. Integrated Approach

Adopting a proactive and integrated approach to tunnel safety is essential.

2. Standards and Regulation

Enhancing regulatory frameworks for tunnel safety to address emerging challenges.

3. Data and Technology

Leveraging data and technology to optimize safety performance.

4. Human and Organisational Factors

Prioritising safety culture and human factors in safety management.

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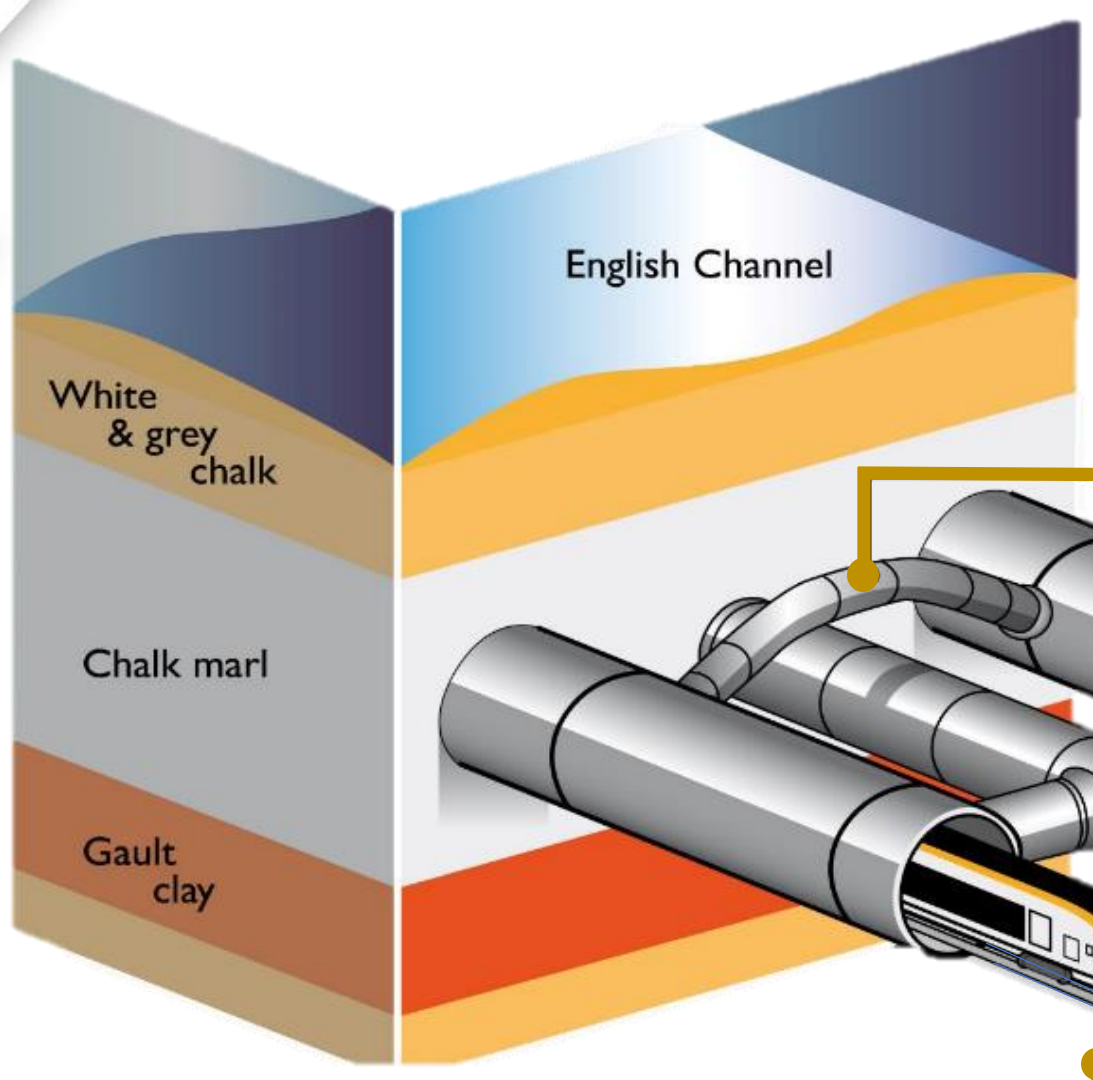
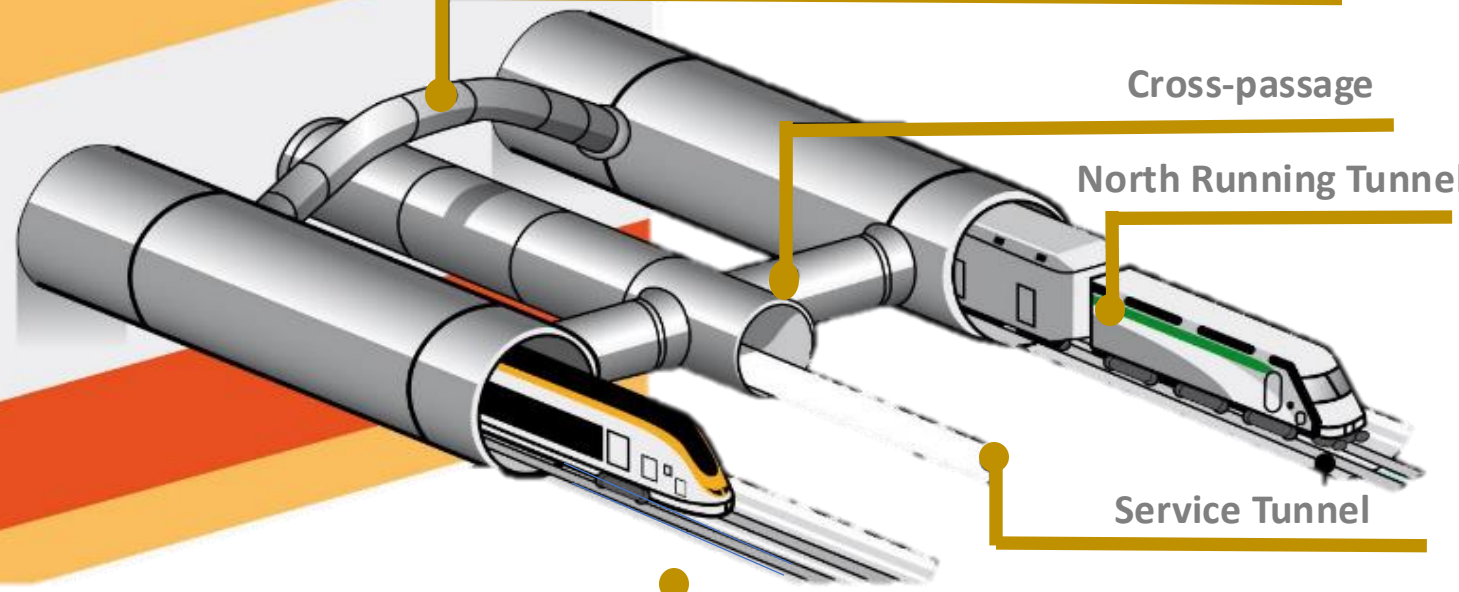
Thank you!

Eurotunnel Context



3 tunnels



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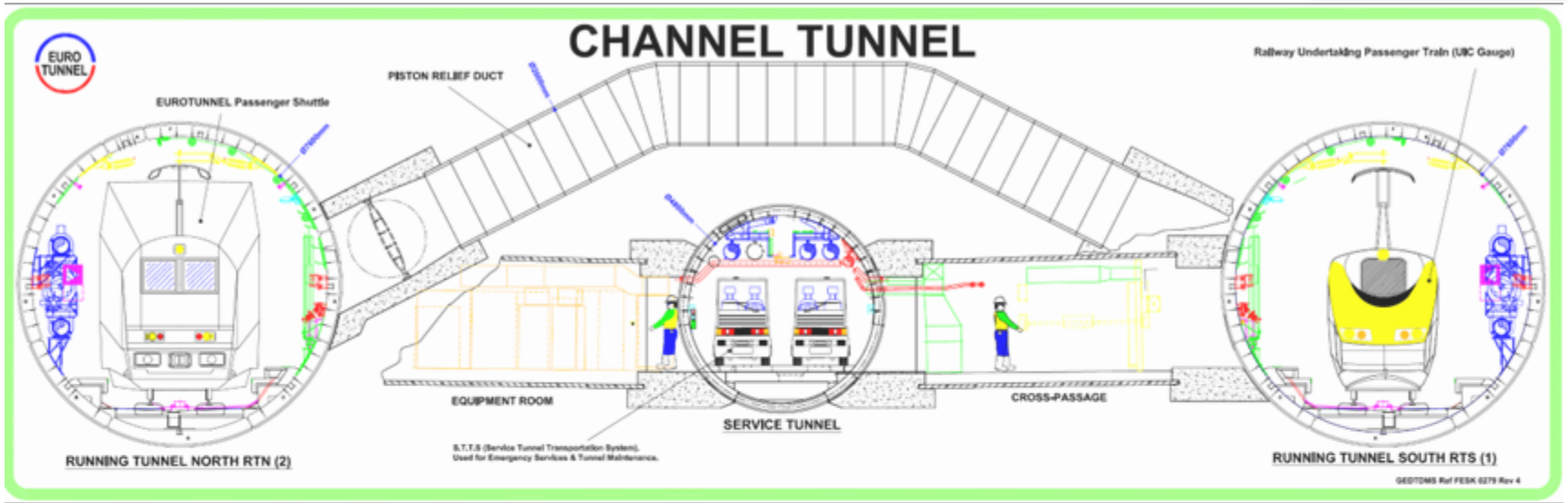
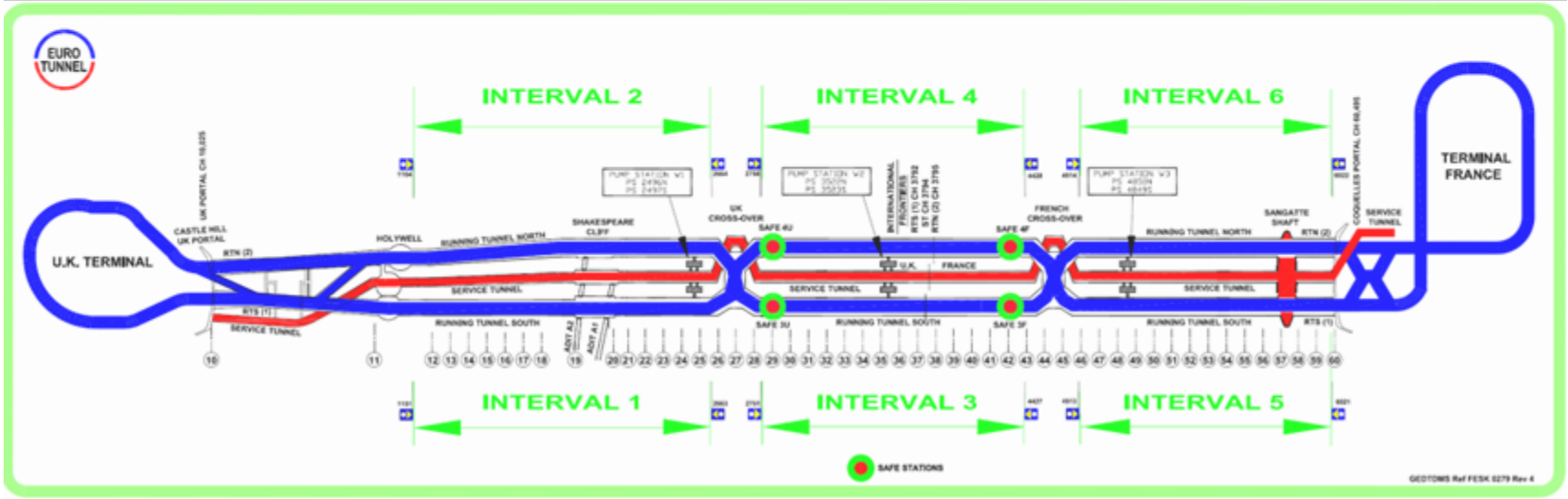
Eurotunnel Context





Embedding Human and Organisational Factors

Key Aspects of Human Factors

- Safety Culture: A just culture and open reporting system encourage learning from mistakes and enhance safety leadership.
- Training and Competency: Regular training sessions and competency assessments ensure that our crew is well-prepared to handle emergencies.
- Fatigue Management: We implement measures to manage fatigue among our staff, ensuring they are alert and capable of performing their duties safely.

Challenges and Solutions

- Error Modes and Human Performance Limitations: Understanding and addressing human performance limitations is crucial for preventing errors.
- Modelling and Predicting Human Behaviour: Predicting human behaviour during tunnel evacuations is challenging due to the shortage of data. We continuously work on improving our evacuation models.