INVESTIGATING DIFFERENT OPERATIONAL SCENARIOS FOR THE PROPOSED EMERGENCY VENTILATION SYSTEM IN FURKA TUNNEL

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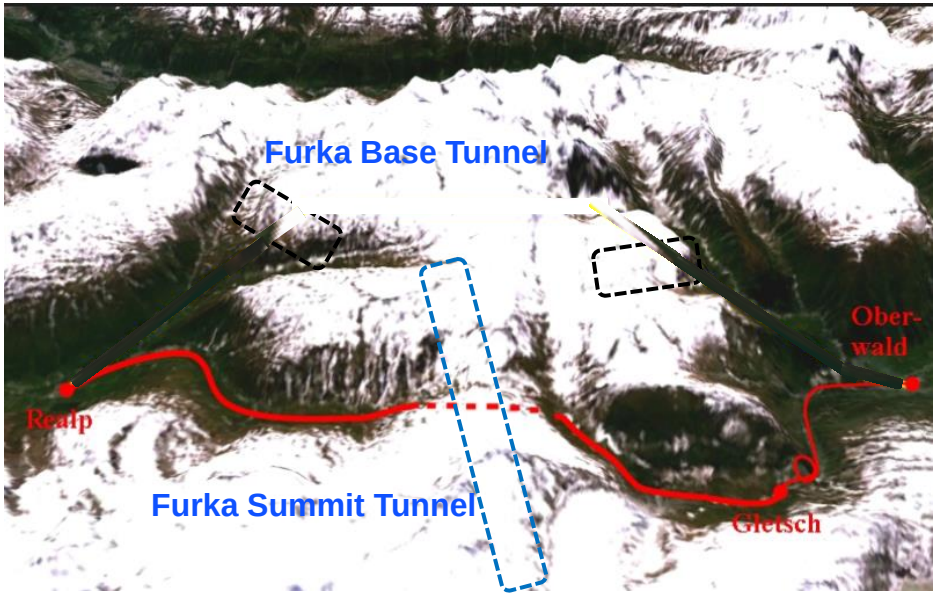
PRESENTATION OUTLINE

- Background
- Ventilation
- Aim & Objectives
- Methodology
- Investigated Scenarios
- Results
- Conclusions

BACKGROUND

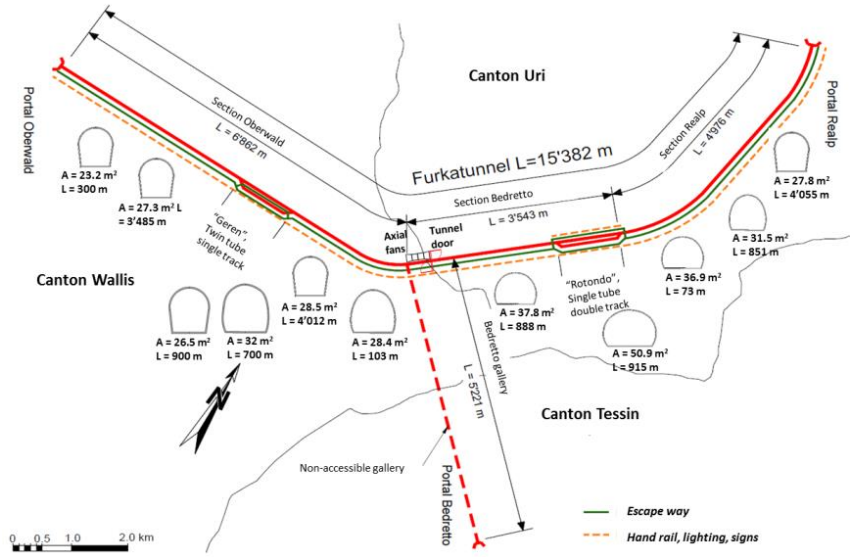
- Swiss cantons of Uri and Wallis were connected by Furka Summit Tunnel (opened in 1926)
- 15.4 km long Furka base tunnel replaces Furka Summit tunnel in 1982
- Two cross junctions namely “Geren (single track twin tube) ” and “Rotondo (double track single tube)”
- One access gallery “Bedretto” is located mid way of tunnel
- Bi-directional train traffic
- Categorized “C” according to swiss guide line “*Sicherheitsanforderungen für bestehende Eisenbahntunnel (10. Aug 2009)*”
- “Update Furka” Tunnel refurbishment project to be completed by 2022

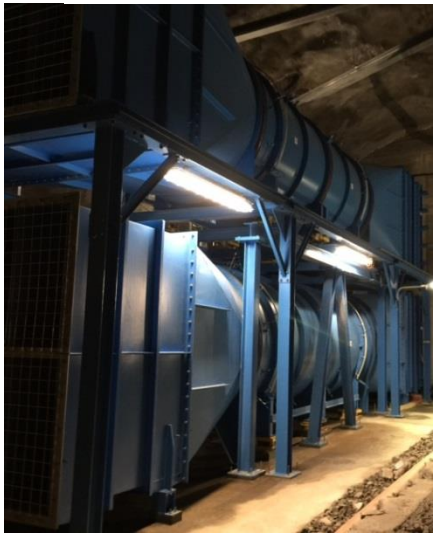


Tunnel Length [m]	Single track tunnel			Twin track tunnel		
	< 100 trains/ day	100 - 300 trains/ day	> 300 trains/ day	< 100 trains/ day	100 - 300 trains/ day	> 300 trains/ day
< 300	A	A	A	A	A	A
300-1000	B	B	B	B	B	B
1000-3000	B	C	C	B	C	C
3000-10’000	C	C	C	C	D	D
> 10’000	C	D	D	C	D	D

VENTILATION: AIM

- Ventilation aims at:
  - ✓ Lower humidity level in tunnel
  - ✓ Constructional ventilation
  - ✓ Improve tunnel safety level in case of fire emergency
- A tunnel door and two axial fans are located mid way of tunnel to control ventilation

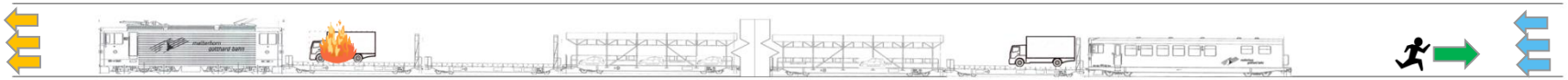




VENTILATION: CONCEPT

- Emergency ventilation is activated only when an emergency train is stationary

  - Fire at front of train: *Ventilation in direction of travel, escape opposite to direction of travel*



  - Fire at rear of train: *Ventilation opposite to direction of travel, escape in direction of travel*

  - Fire location unknown or at middle of train: *Ventilation opposite to direction of travel, escape in direction of travel*

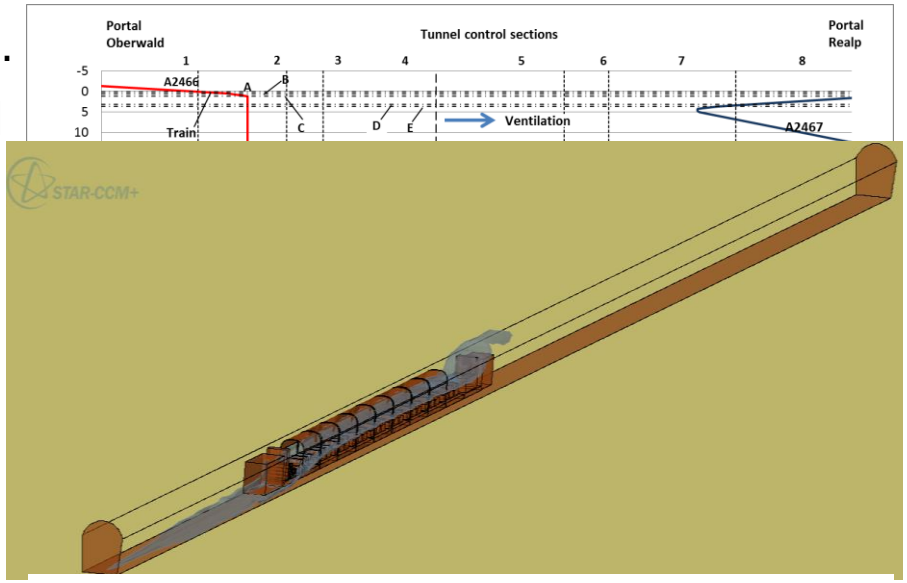
  - No pre-defined direction of flow exist in tunnel

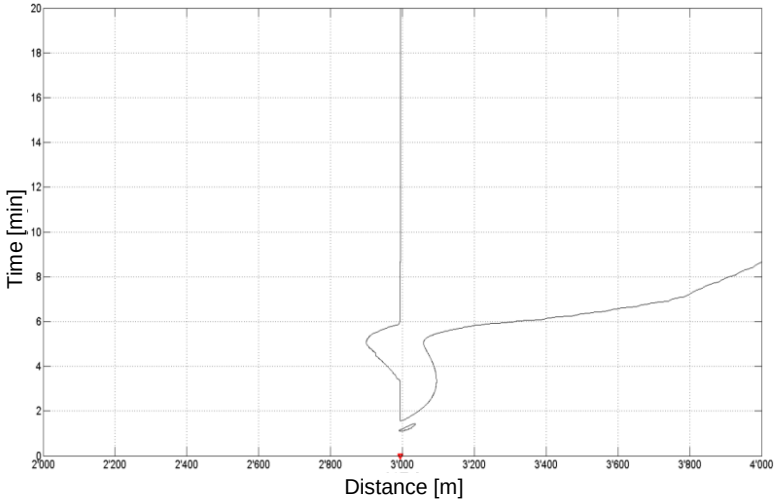
AIM & OBJECTIVES

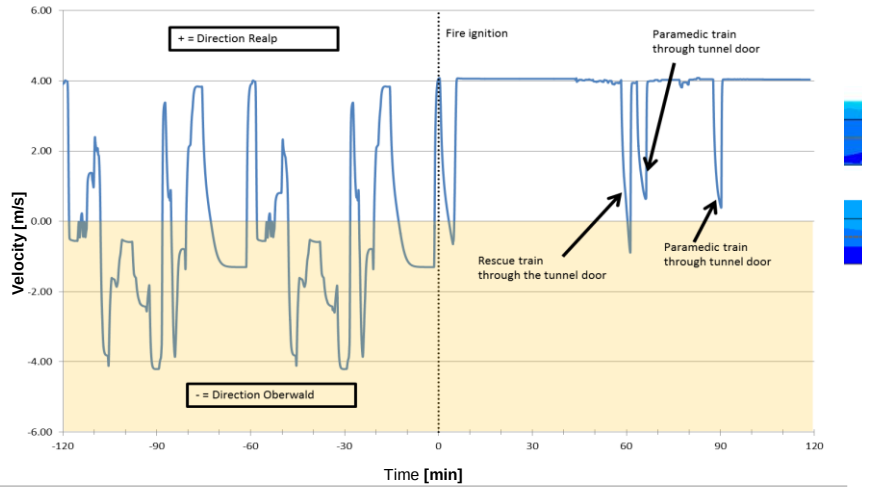
- Proof of the proper functionality of the proposed ventilation system
- Highlight the short comings in the evacuation process in case of a fire emergency
- Evaluate the aero- thermodynamic conditions for the critical most scenario using coupled 1- and 3-dimensional “Computational Fluid Dynamics (CFD)” simulation
- Provide recommendations for the detailed rescue planning

METHODOLOGY

- Distance vs time plot for different events.
- Analyse the flow for different operational scenarios (1-D velocity course)
- Plot distance vs time plot for smoke propagation (1-D visibility contour)
- Investigate 3-D smoke and thermal stratification for critical situations

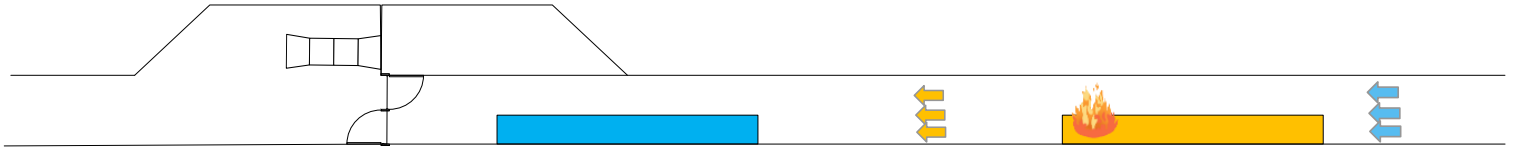






INVESTIGATED SCENARIOS

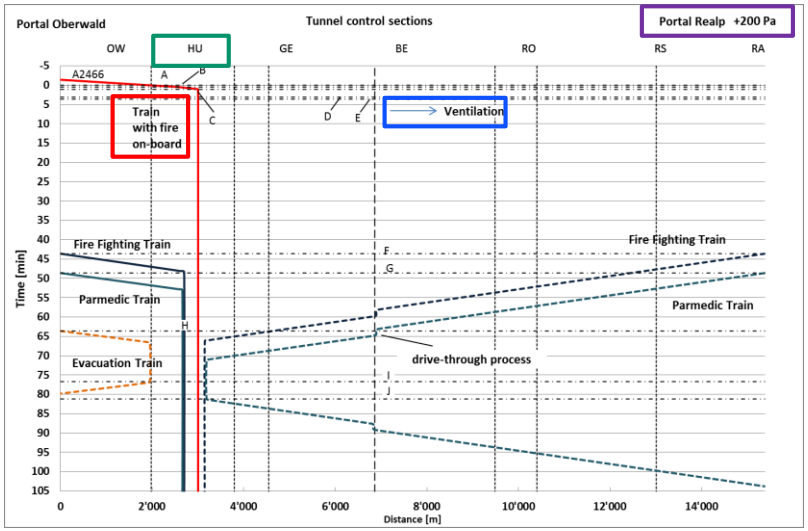
- Standard scenarios
  - Covers 83% operational conditions
  - Assumption of emergency in single track tunnel section
  - HGV fire on vehicle transport train
- Scenario Geren (Low air flow)
  - Accidental stop of train in cross over junction “Geren” (smaller cross section tube)
- Train downstream of emergency train but before the tunnel door

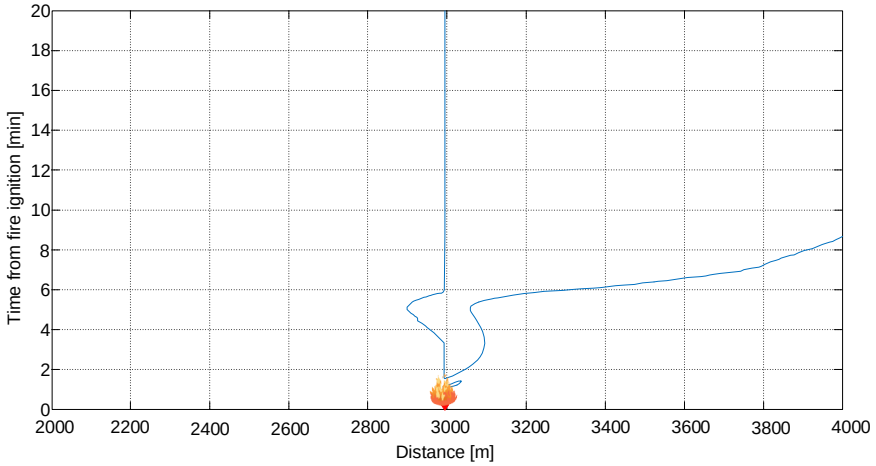


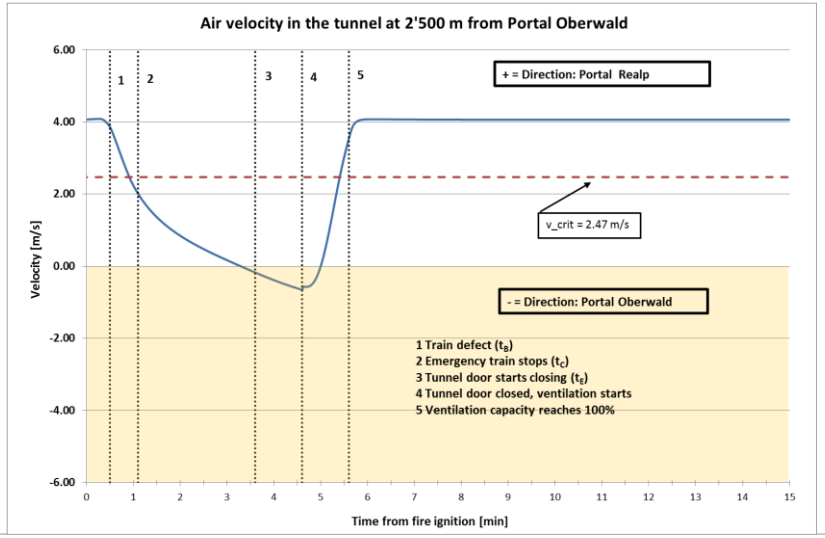
  - Should the door be closed and non burning train should wait for ventilation ?
  - Should the door be closed after the non burning train has passed through the door ?
- Presence of multiple trains in system
- Fire at mid of train or unknown location

RESULTS: STANDARD SCENARIO - VARIATION “V1”

- Oberwald → Realp (A2466)
  - HGV Fire at front
- Emergency stop in section HU
- Ventilation → Realp
  - 1 axial fan in operation
- 200 Pa. adverse portal pressure (opposing fan flow direction)

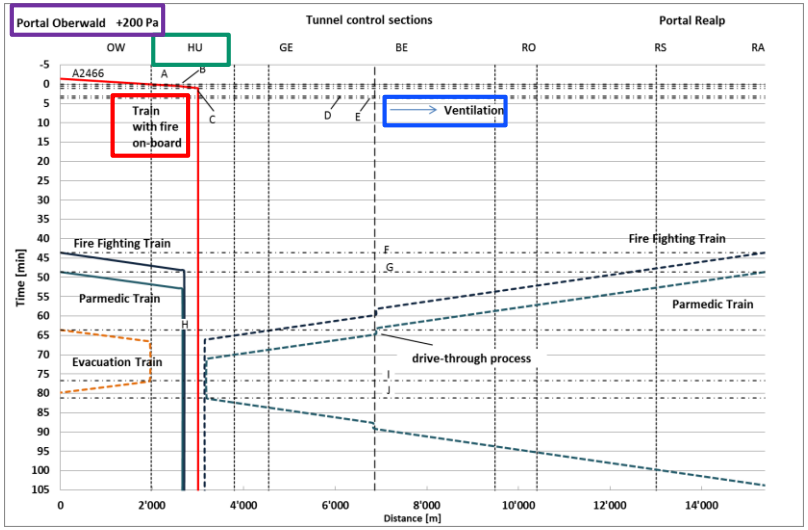


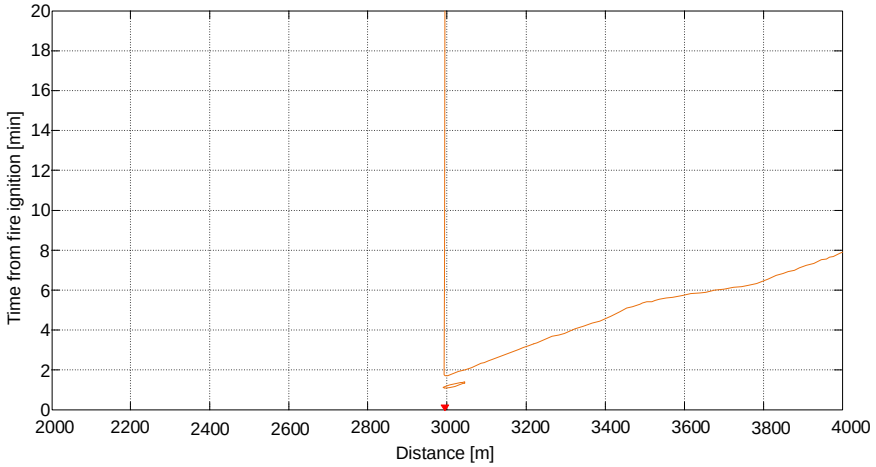


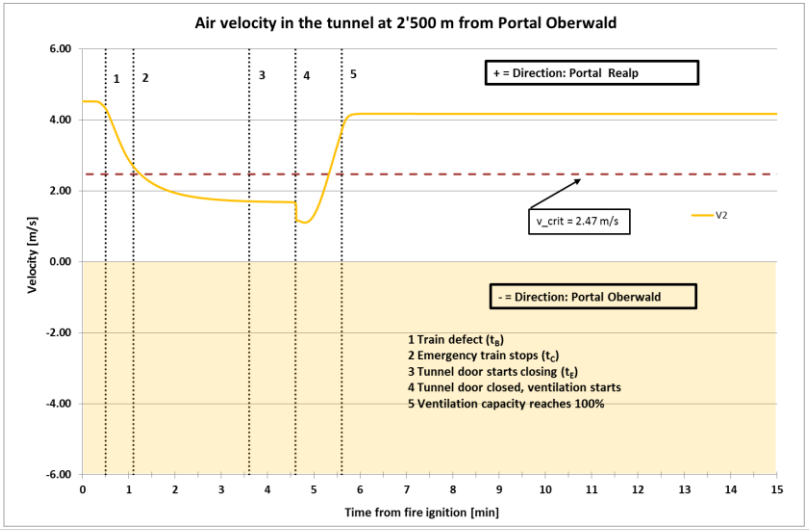


RESULTS: STANDARD SCENARIO - VARIATION "V2"

- Oberwald → Realp (A2466)
  - HGV Fire at front
- Emergency stop in section HU
- Ventilation → Realp
  - 1 axial fan in operation
- 200 Pa. assisting portal pressure (pressure in fan flow direction)

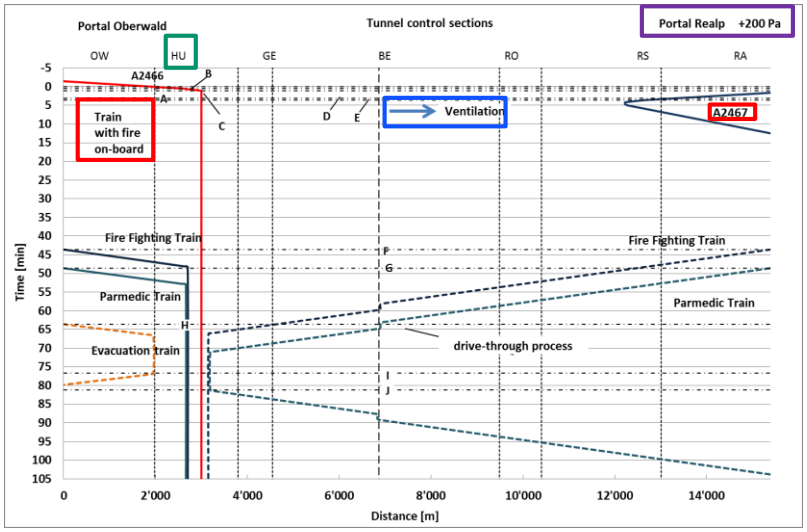


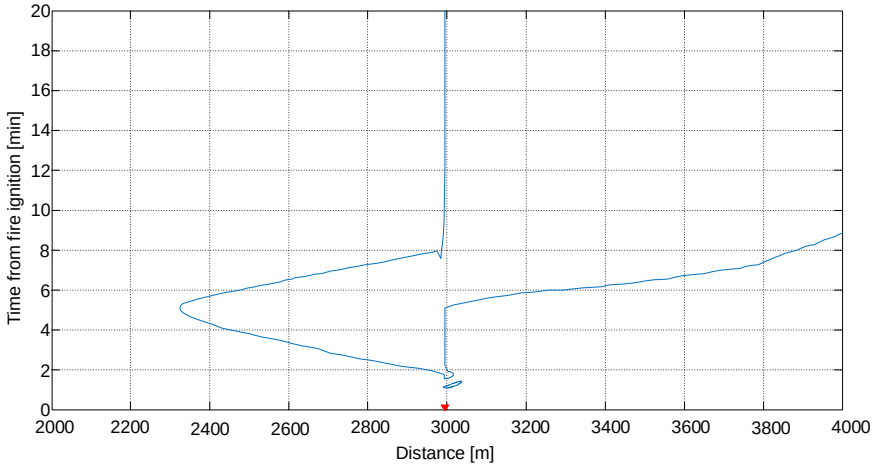


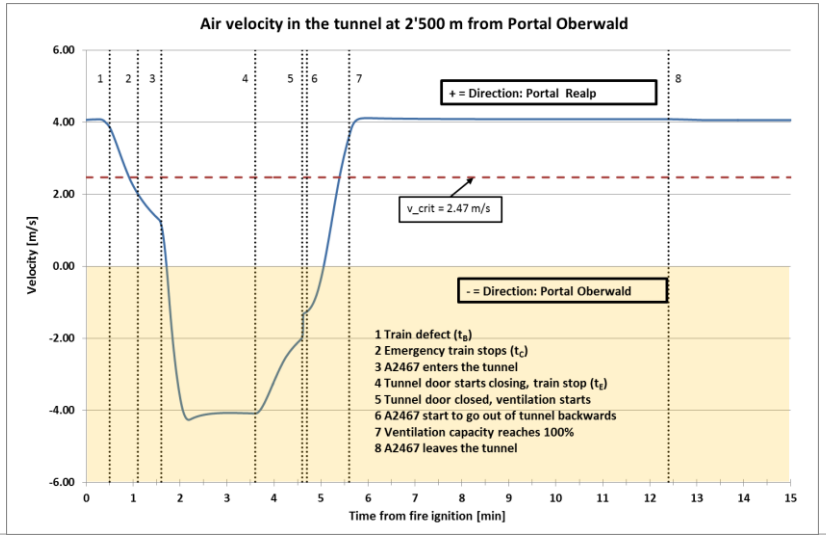


RESULTS: STANDARD SCENARIO - VARIATION “V3”

- Oberwald → Realp (A2466)
  - HGV Fire at front
- Realp → Oberwald (A2467)
- Emergency stop in section HU
- Ventilation → Realp
  - 1 axial fan in operation
- 200 Pa. adverse portal pressure (opposing fan flow direction)

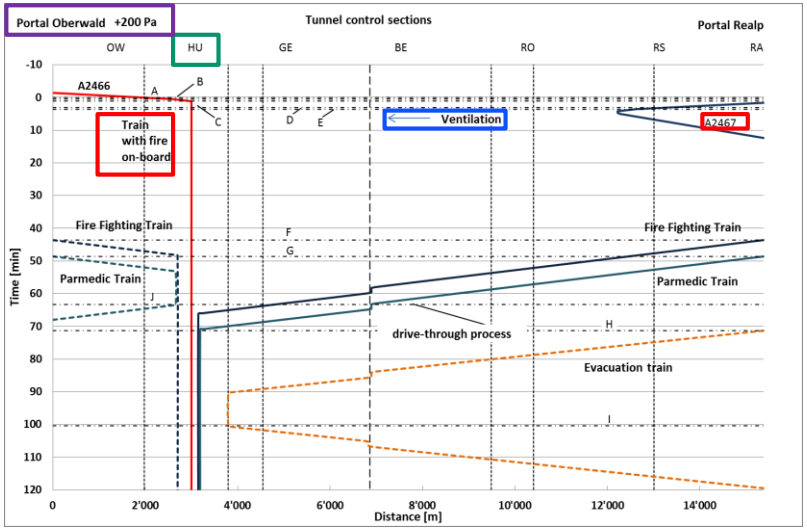


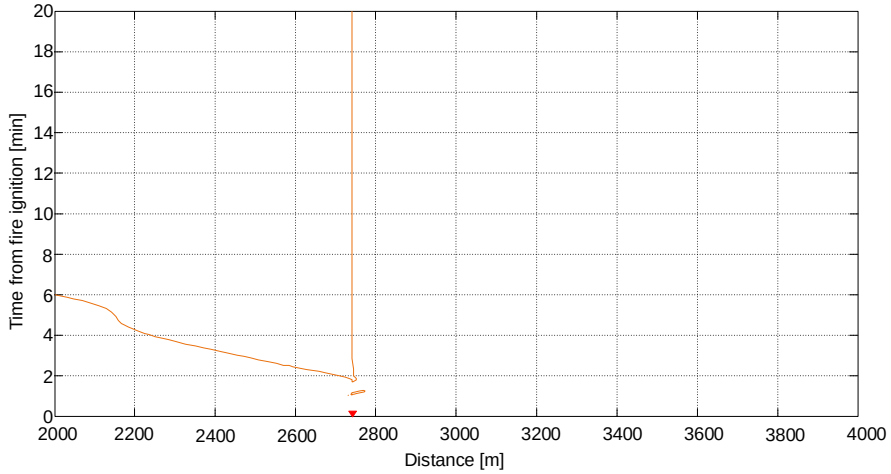


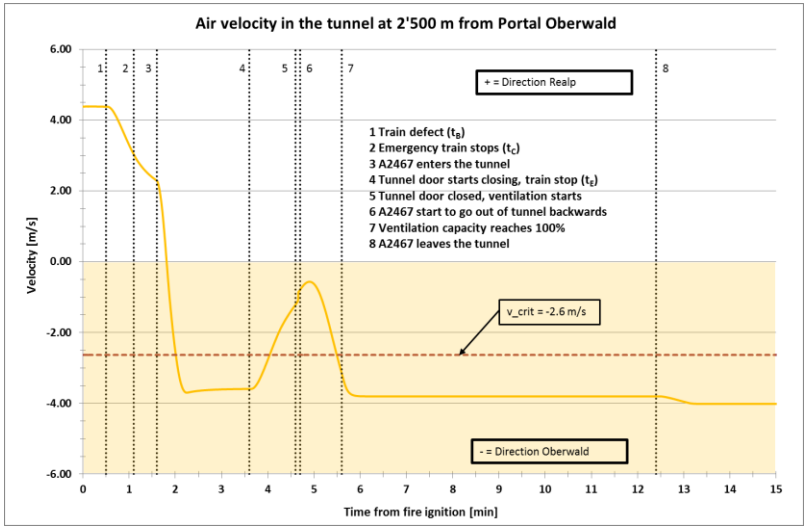


RESULTS: STANDARD SCENARIO - VARIATION “V4”

- Oberwald → Realp (A2466)
  - HGV Fire at rear
- Realp → Oberwald (A2467)
- Emergency stop in section HU
- Ventilation → Oberwald
  - 1 axial fan in operation
- 200 Pa. adverse portal pressure (opposing fan flow direction)

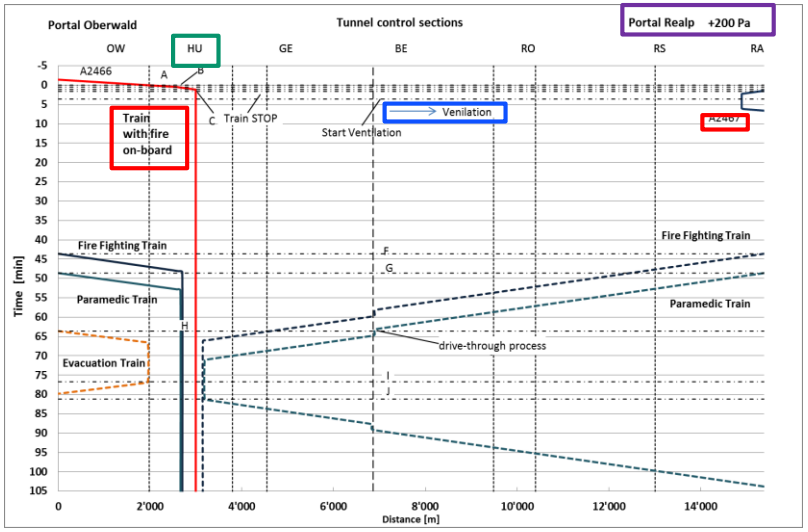


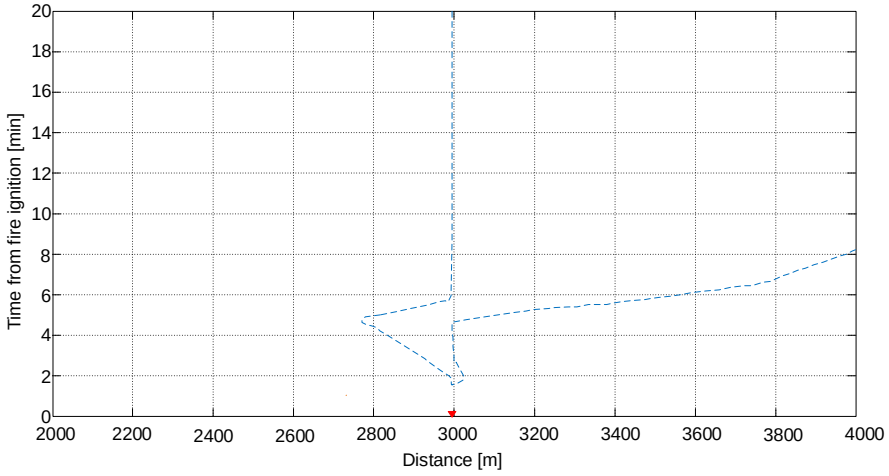


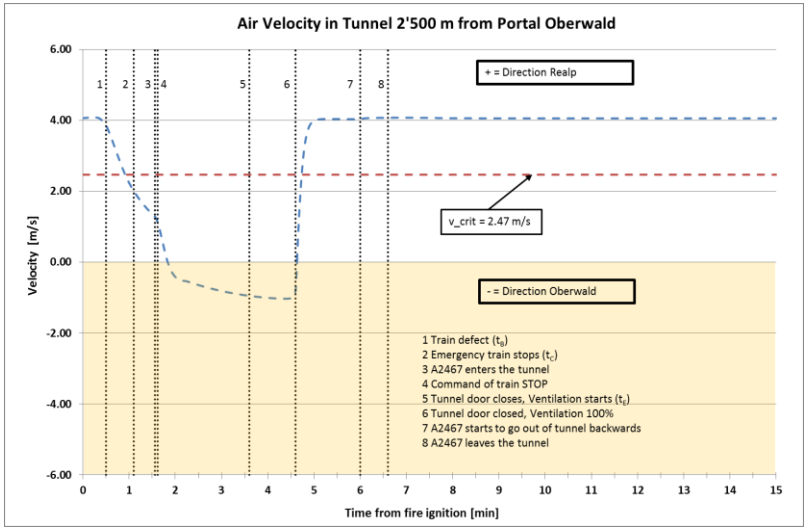


RESULTS: STANDARD SCENARIO - VARIATION “V5”

- Similar to variation 3 with following operational changes:
  - Immediate contact with control centre as soon as train comes to a stop
  - Immediate STOP command (within 30 seconds) from control centre for all trains in the tunnel network
  - Simultaneous closing of doors and starting of ventilation fans

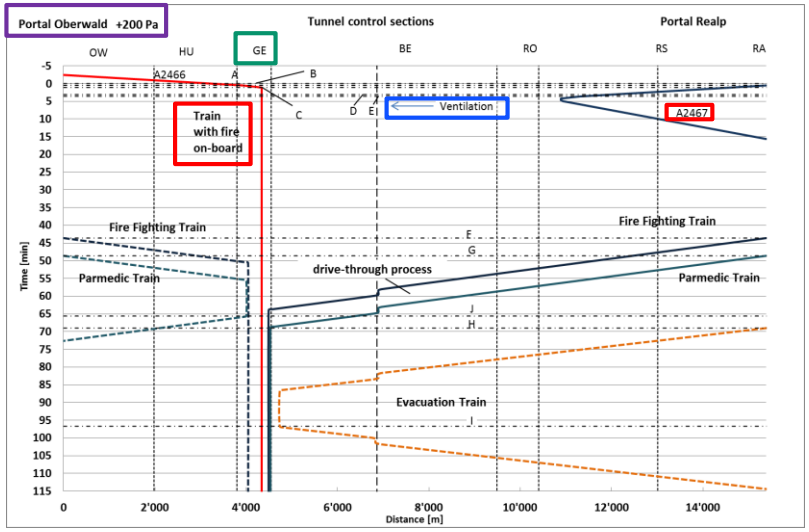


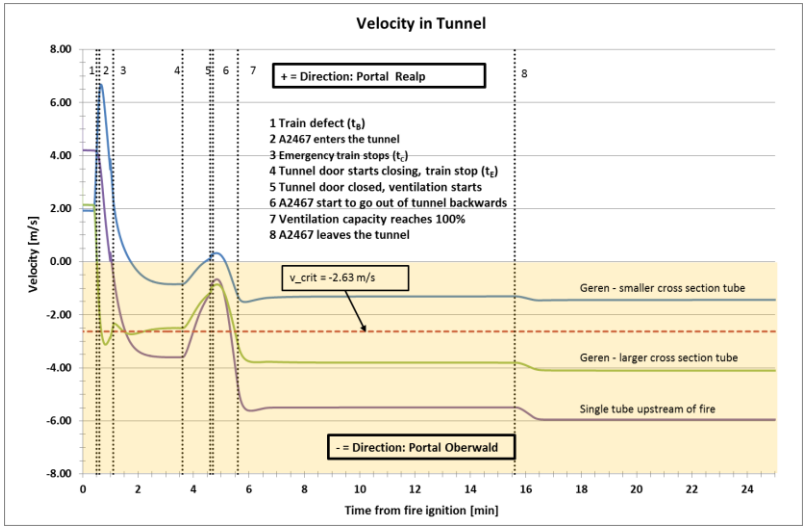




RESULTS: SCENARIO GEREN

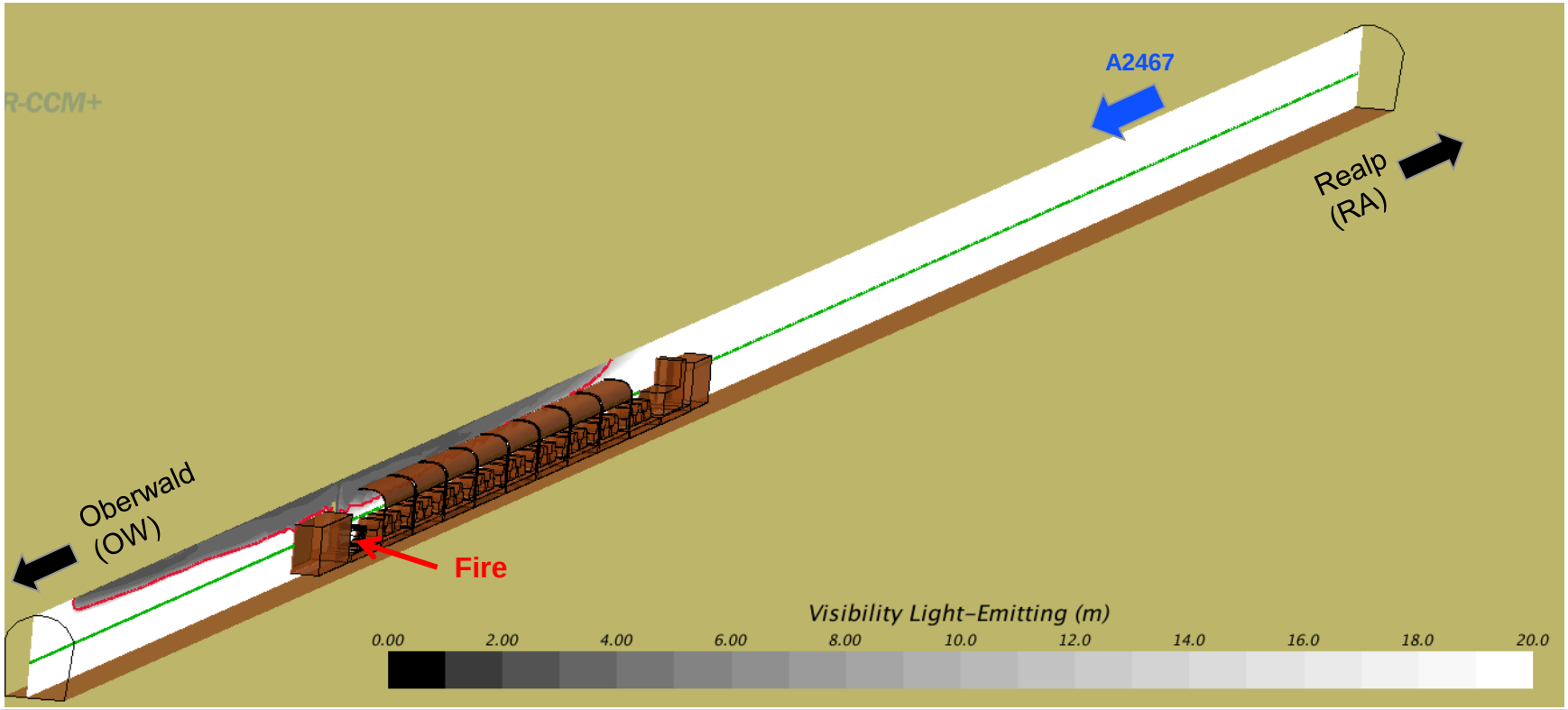
- Oberwald → Realp (A2466)
  - HGV Fire at rear
- Realp → Oberwald (A2467)
- Emergency stop in section GE
- Ventilation → Oberwald
  - 2 axial fan in operation
- 200 Pa. adverse portal pressure (opposing fan flow direction)
- 3-D CFD was used to see smoke propagation and extent of back-layering





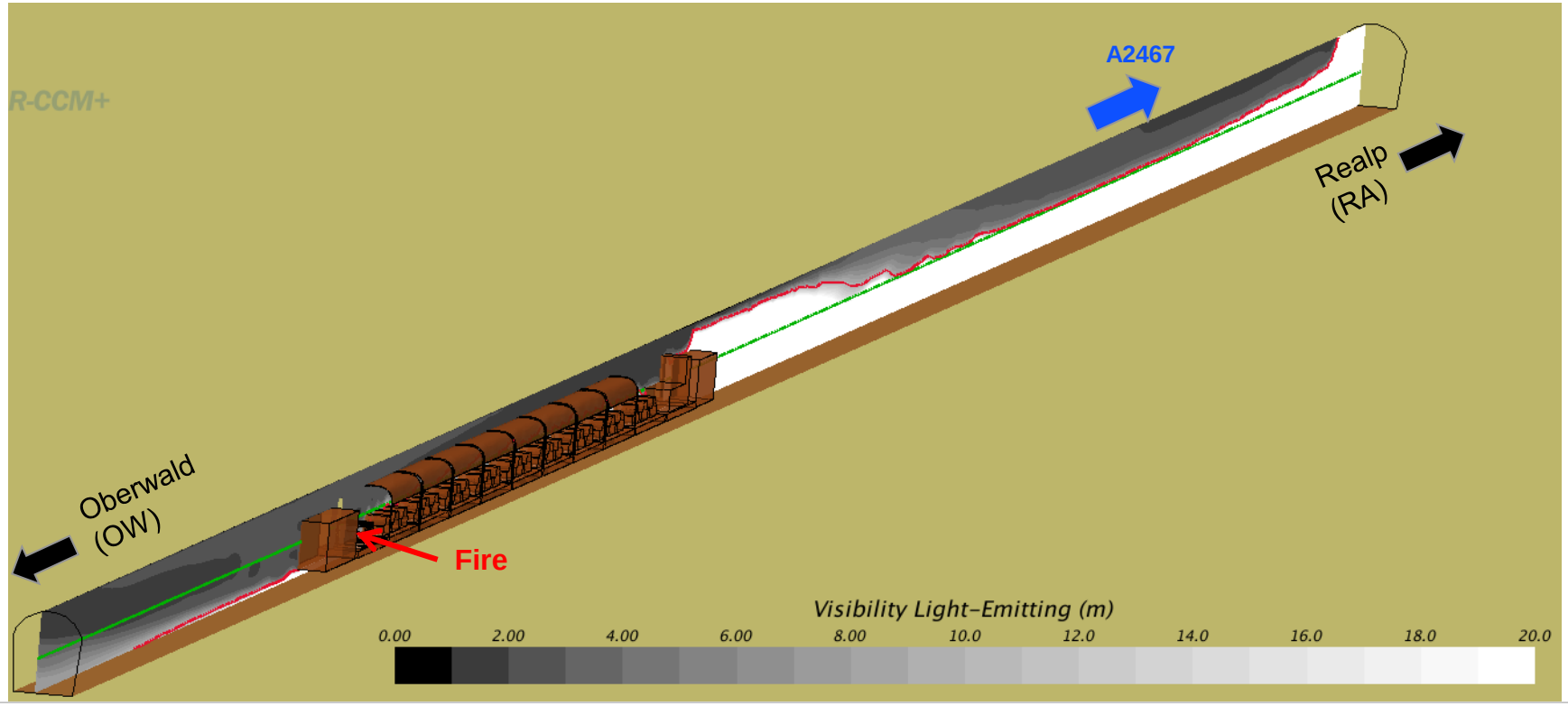
RESULTS: SCENARIO GEREN

- 2 minutes after fire ignition
  - Emergency train is stopped
  - A2467 moving towards OW
  - Fire power 12 MW
  - Ventilation not started



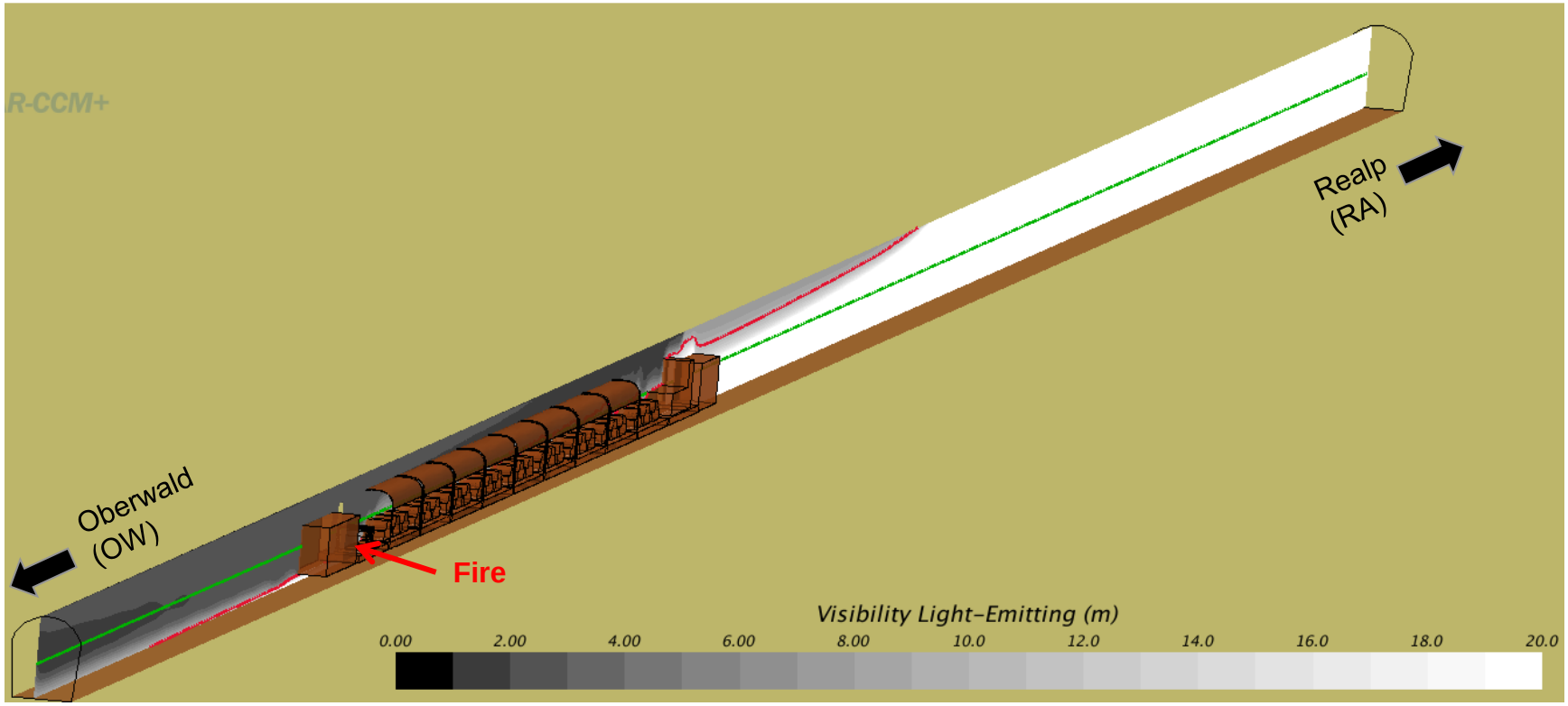
RESULTS: SCENARIO GEREN

- 6 minutes after fire ignition
  - Emergency train is stopped
  - A2467 moving towards RA
  - Fire power 30 MW
  - Ventilation 100%



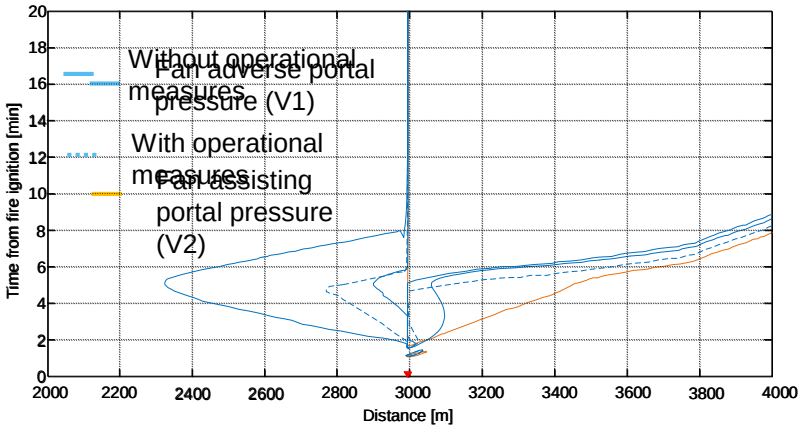
RESULTS: SCENARIO GEREN

- 20 minutes after fire ignition
  - Emergency train is stopped
  - A2467 left the tunnel
  - Fire power 30 MW
  - Ventilation 100%

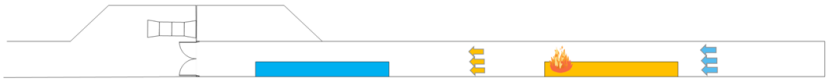


CONCLUSIONS

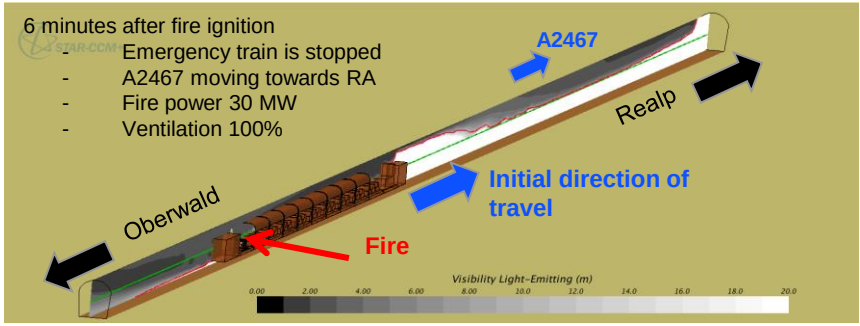
- Effect of adverse portal pressure on the ventilation system
- Operational measures:
  - Early stop signal
  - Simultaneous closing of doors and starting of ventilation fans
  - Non-emergency trains should evacuate after stabilized flow conditions occur in tunnel
- Ventilation system should be kept simple and reliable
- A calculated risk has to be considered for certain extreme cases (e.g. “Geren”)
- Emergency ventilation should run at its full capacity
- Ventilation control in its current implementation improves the escape conditions for Furka tunnel



Train downstream of emergency train but before the tunnel door



- Should the door be closed and non burning train should wait for ventilation ?
- Should the door be closed after the non burning train has passed through the door ?



THANK YOU

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