

Protection and air-conditioning concept in emergency and rescue trains

Presented by Samuel Koeger

Introduction:

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- Since 34 years in Beth-El Industries Ltd.
 - R&D Manager
 - Export Manager
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- Member of standards committee ISO TC292 WG 10

Presentation Overview:

1. Underground railway transportation
2. Concept of underground firefighting and rescue trains
3. Air filtration systems for rescue trains
4. Air conditioning systems for rescue trains

1. Underground railway transportation

Railway tunnels in use, per country:

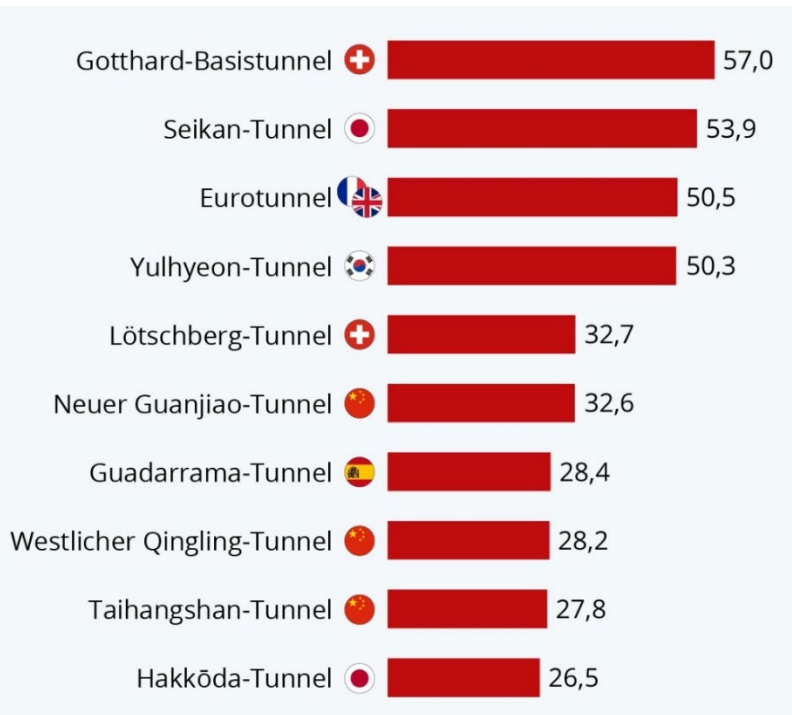
Country	Length (km)
China	1,985.13
Japan	286.04
Switzerland	171.18
South Korea	161.17
Italy	93.89
Austria	55.67
Spain	53.02
France/UK	50.45
Norway	34.10
Taipei	22.67
Italy/Switzerland	19.80
Uzbekistan	19.20
France	18.50
Russia	15.30
Peru	14.72
Canada	14.70
Turkey	13.60
Finland	13.50
Italy/France	13.50
South Africa	13.50
Total	3,069.65

Railway tunnels under construction, per country:

Country	Length (km)
China	2,021.19
Japan	278.45
Italy	98.94
Austria	60.20
France/Italy	57.50
Austria/Italy	55.00
India	50.42
United	29.54
Germany/Denmark	17.14
Total	2,668.38

1. Underground railway transportation

Longest railway tunnels (km):

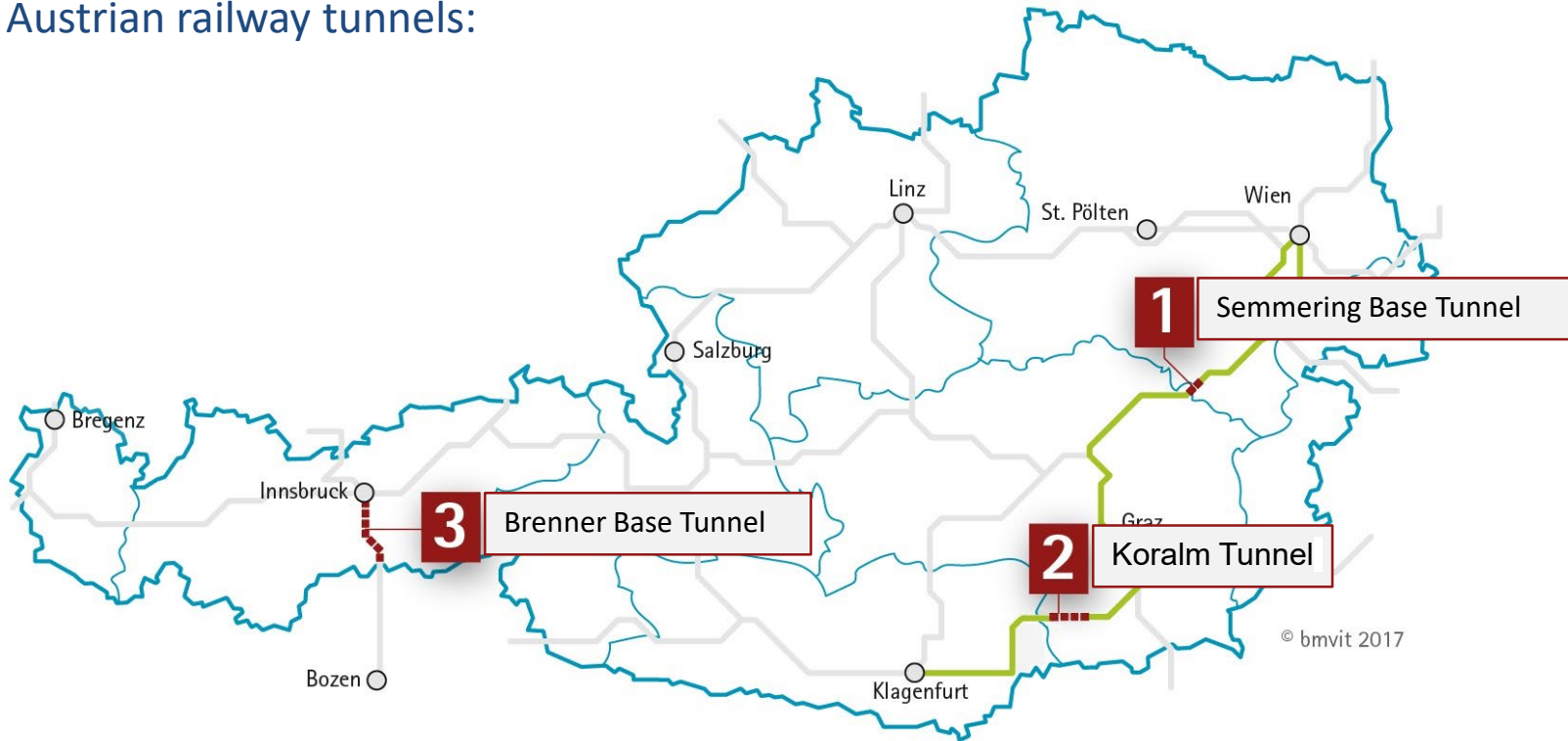


Alpine railway tunnels:



1. Underground railway transportation

Austrian railway tunnels:



1. Underground railway transportation

Hazards of long train tunnels, in case of accidents:



1. Fire Risks
2. Ventilation Issues
3. Structural Integrity
4. Emergency Response
5. Communication Problems
6. Evacuation Challenges

1. Underground railway transportation

Hazards of long train tunnels, in case of accidents:

1. **Fire Risks:** Fires in long tunnels can be particularly dangerous due to the confined space, which can trap heat and smoke, making it difficult for passengers to evacuate and for rescue teams to reach the site.
2. **Ventilation Issues:** Proper ventilation is crucial in long tunnels to manage air quality and remove smoke in case of a fire. Poor ventilation can exacerbate the effects of smoke and toxic gases.
3. **Structural Integrity:** The length and depth of long tunnels can make them more susceptible to structural issues, such as collapses or water ingress, which can pose significant risks to trains and passengers.
4. **Emergency Response:** The distance and complexity of long tunnels can delay emergency response times, making it harder for rescue teams to reach and assist passengers quickly.
5. **Communication Problems:** Maintaining reliable communication within long tunnels can be challenging, which can hinder coordination during emergencies.
6. **Evacuation Challenges:** Evacuating passengers from a long tunnel can be difficult, especially if the train is far from an exit or emergency exit points are not well-marked or accessible.

2. Concept of underground firefighting and rescue trains



Purpose:

1. Evacuation and rescue operations from smoke-filled tunnels (for 300+ passengers)
2. Fire extinguishing operations at railway yards
3. Pulling and towing of trains
4. Train maintenance
5. Preventive wetting of railway embankments

2. Concept of underground firefighting and rescue trains

Requirements:

Technical Implementation:

Self-sufficient operation in emergency situations

Trimodal electric hybrid drive, energy supply options from:

- the overhead line
- underfloor traction batteries
- diesel generator

Fire extinguishing

- Capacity for water and foam on board (40 m³ of water and 1 m³ of foam)
- Extinguishing systems either at normal pressure for classic firefighting (10 bar) or high pressure spray for cooling or prevention purposes (100 bar).

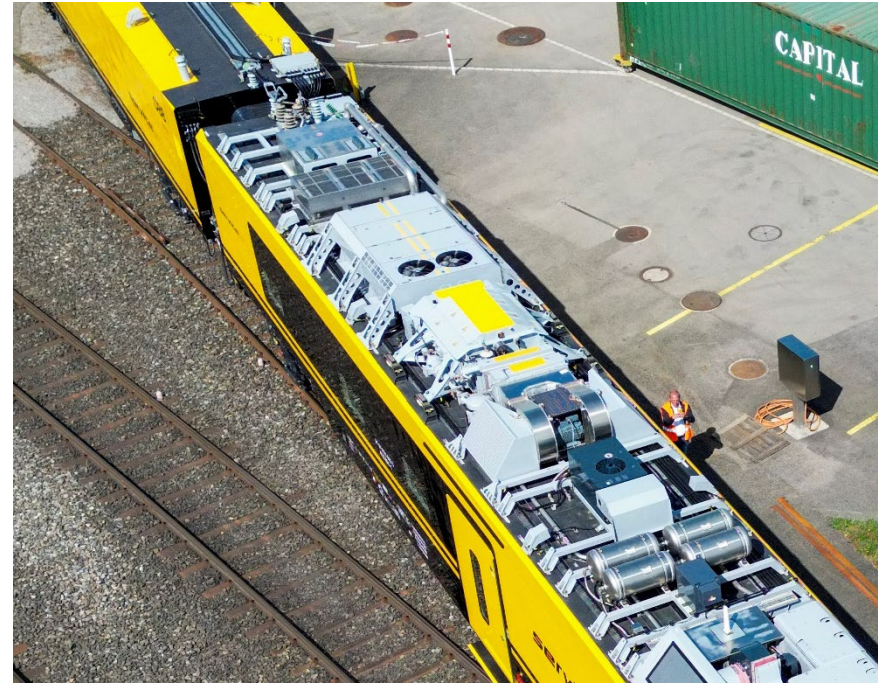
Protection from smoke gases

- Over-pressurization
- Air conditioning system, equipped with special filters

2. Concept of underground firefighting and rescue trains



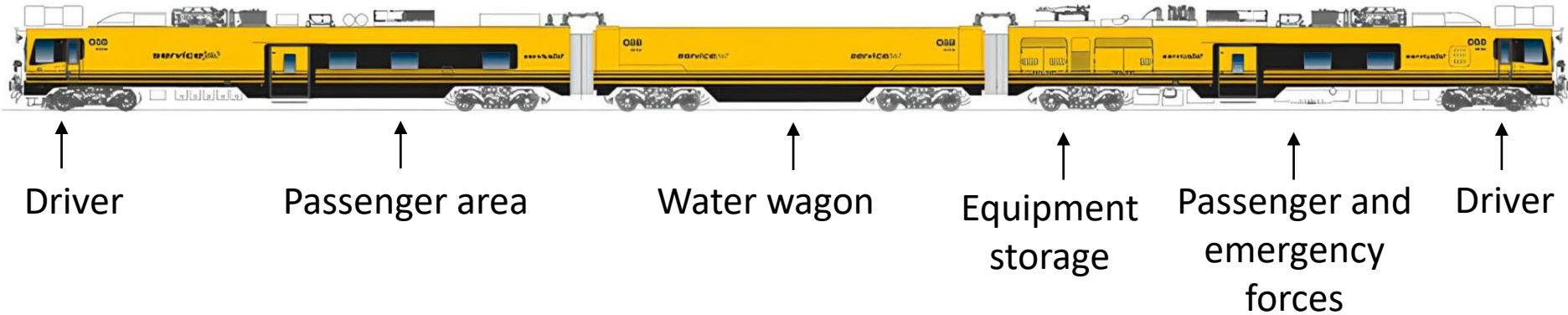
2. Concept of underground firefighting and rescue trains



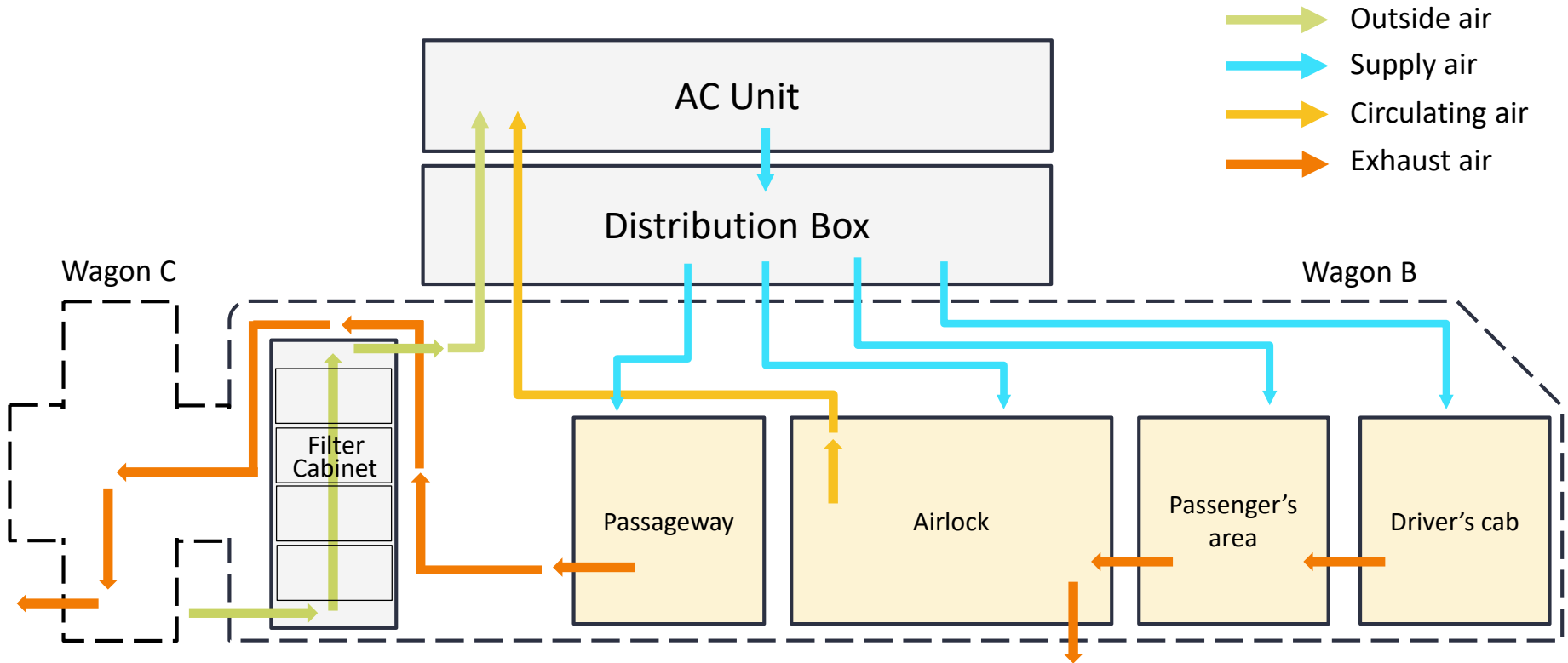
2. Concept of underground firefighting and rescue trains



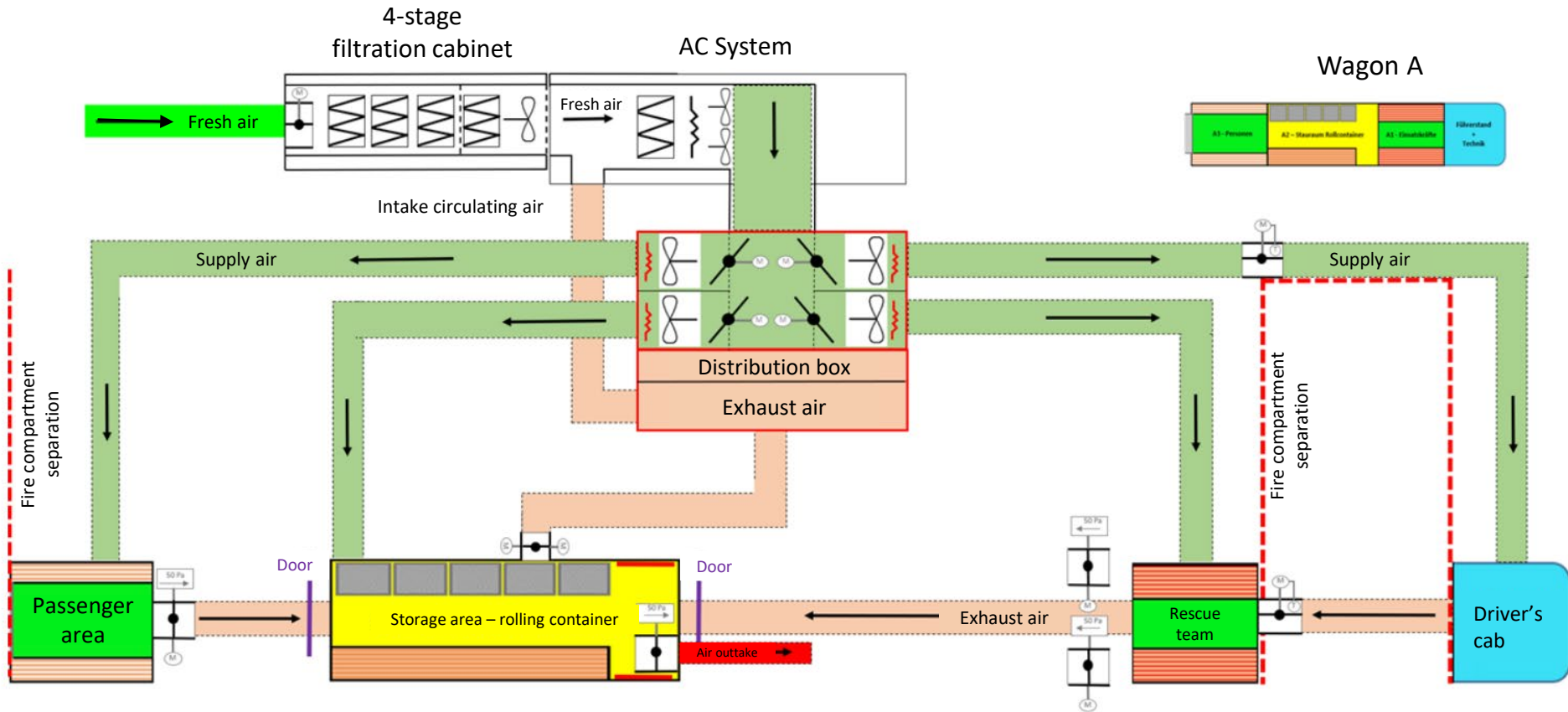
2. Concept of underground firefighting and rescue trains



3. Air filtration systems for rescue trains

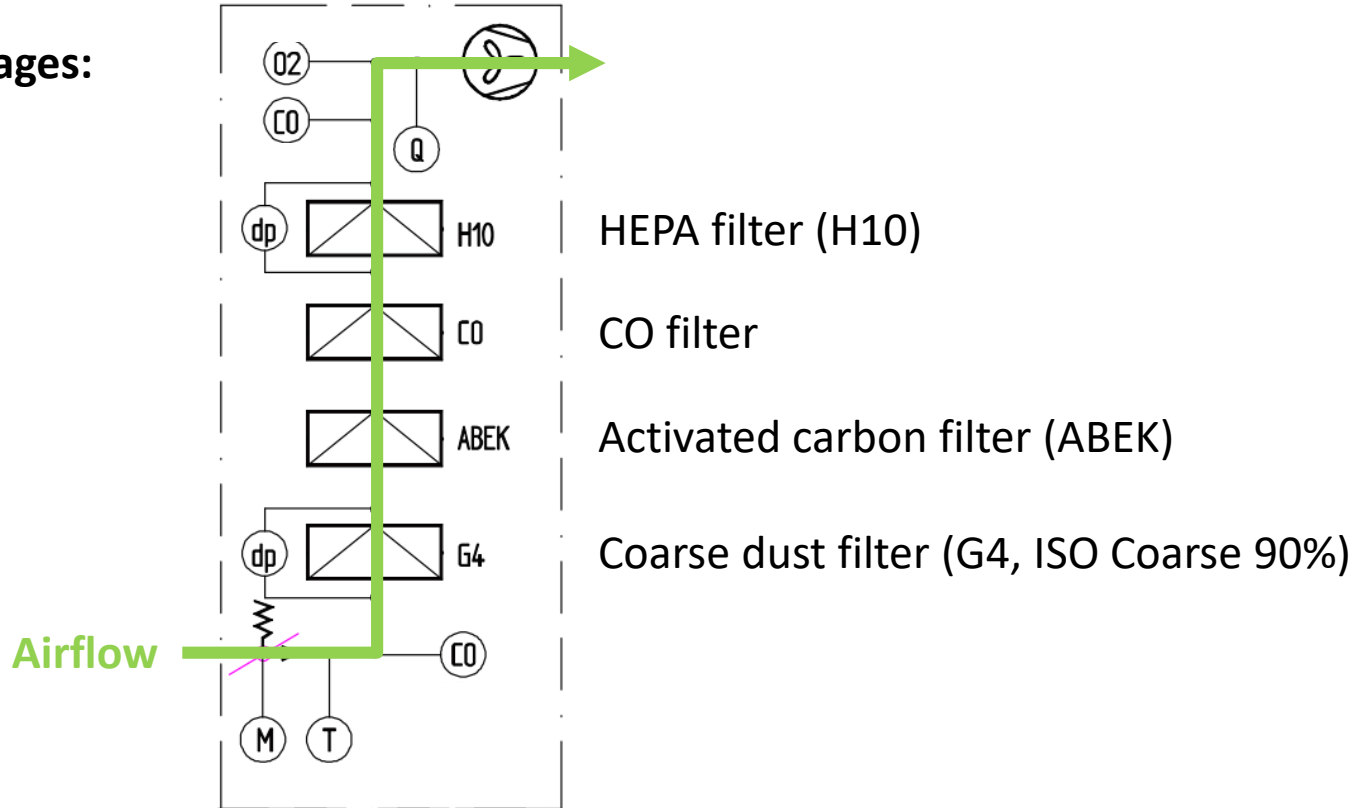


3. Air filtration systems for rescue trains



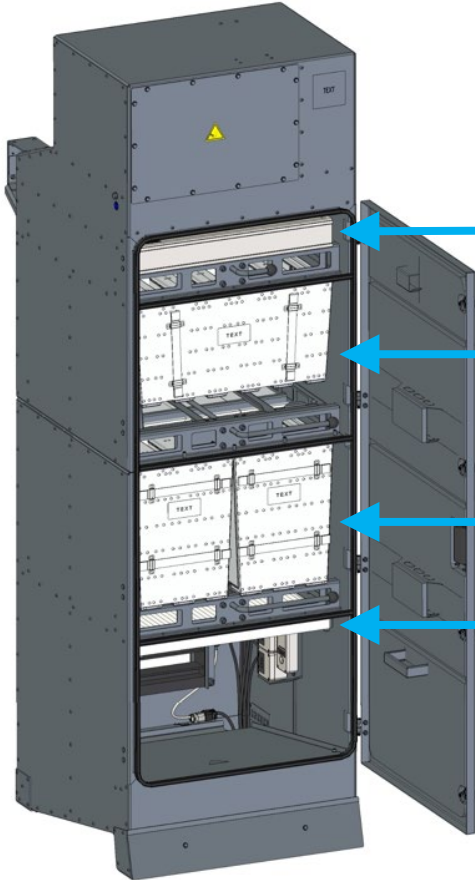
3. Air filtration systems for rescue trains

Filtration stages:



3. Air filtration systems for rescue trains

Filtration stages:



Filtr. Stage	Filter	Filter media	Filtration technology	Activation
4	HEPA H10	Micro glass fiber filter media	Particle filtration - particles caused by fire	In case of high dust levels and risk of smoke
3	CO filter	Catalyst	Catalyzation of toxic carbon monoxide (CO) to relatively harmless carbon dioxide (CO2)	Upon reaching the CO warning threshold of 30 ppm
2	Activated carbon filter (ABEK)	Activated carbon	Gas filtration - protect people + CO filter from harmful gases	If smoke is sighted / chemical accidents involving toxic gases
1	Coarse dust filter	Synthetic fiber fleece	Dust from outdoor air	Permanently installed in the filter cabinet

The outside air must contain at least 18% oxygen.
If too little oxygen is in the outside air, oxygen bottles are used.

3. Air filtration systems for rescue trains



3. Air filtration systems for rescue trains

Air tightness of the vehicle

1. The vehicle is completely accessible from driver's cab to driver's cab
2. Protected from smoke penetration by overpressure (with the outside doors closed) –
 - Non-emergency: + 10 Pa
 - Emergency: + 50 Pa
3. In case of smoke in a tunnel, if the outside doors are open, smoke protection curtains reduce the amount of smoke entering the vehicle's locks.
4. If both the interior doors and exterior doors are open, internal overpressure decreases. But since filtered air is continuously pumped into the pressure protection zones, slight overpressure can be obtained, and ingress of contaminated air is counteracted.

3. Air filtration systems for rescue trains

Sensors:

- Temperature regulation
- Pressure in different zones
- Airflow volume
- CO (Carbon Monoxide)
- CO₂ (Carbon Dioxide)
- O₂ (Oxygen)
- Filter monitoring

Standards for filtration:

- DIN EN 14387: Respiratory protective devices - Gas filter(s) and combined filter(s) - Requirements, testing, marking
- GB 21976.7-2012 - Escape apparatus for building fire - Part 7: Filtering respiratory protective devices for self-rescue from fire

Standards for AC:

- DIN EN 14750: Railway applications - Air conditioning for urban and suburban rolling stock
- DIN EN 14813: Railway applications - Air conditioning for driving cabs

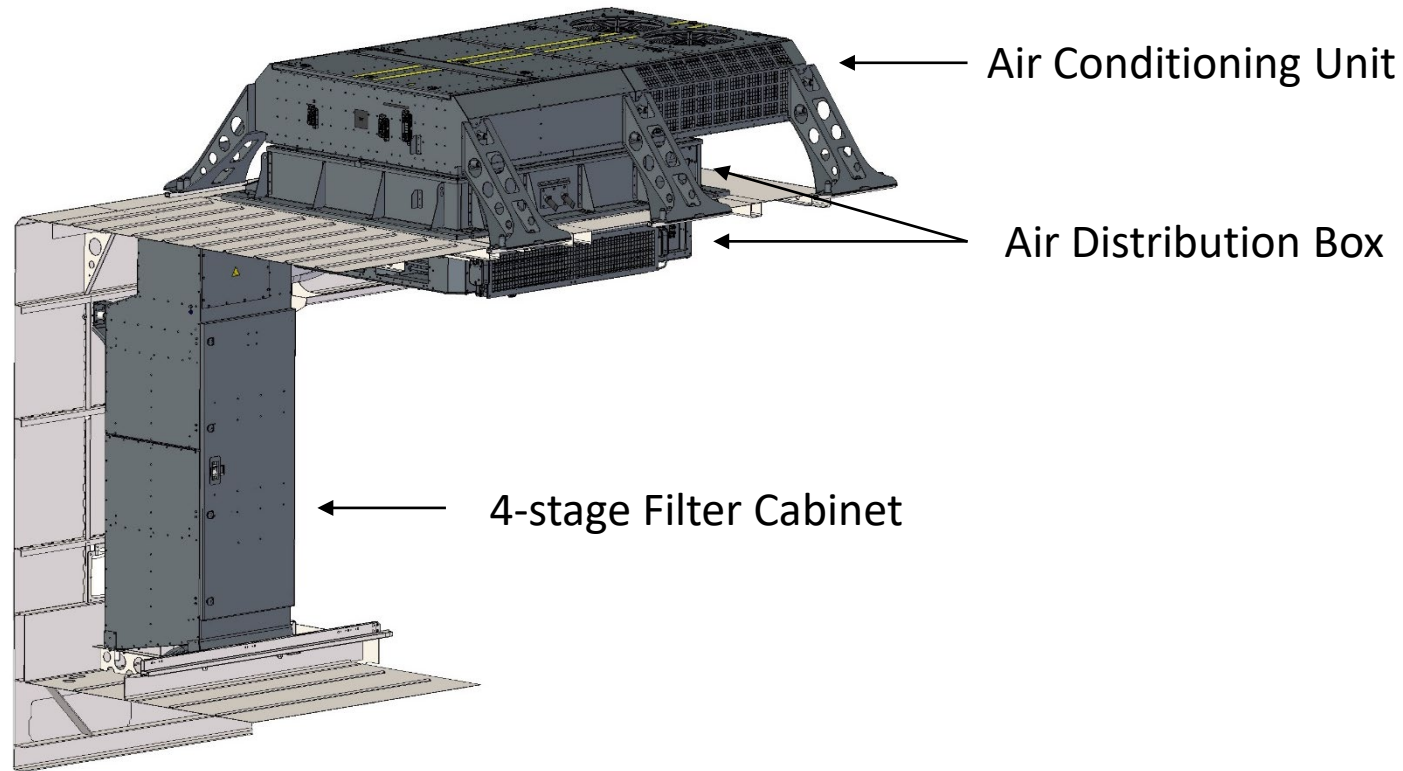
4. Air conditioning systems for rescue trains

The entire vehicle and all zones are supplied by two air conditioning units, installed on wagon A and B.

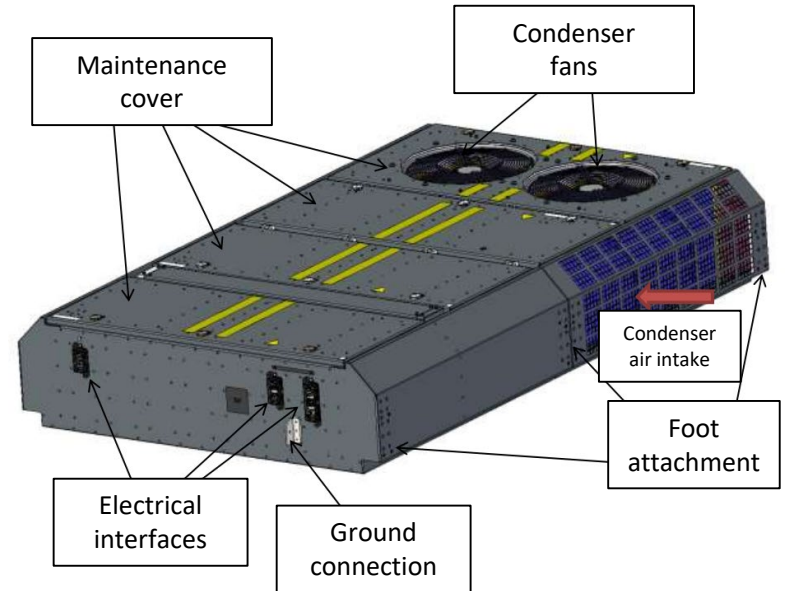
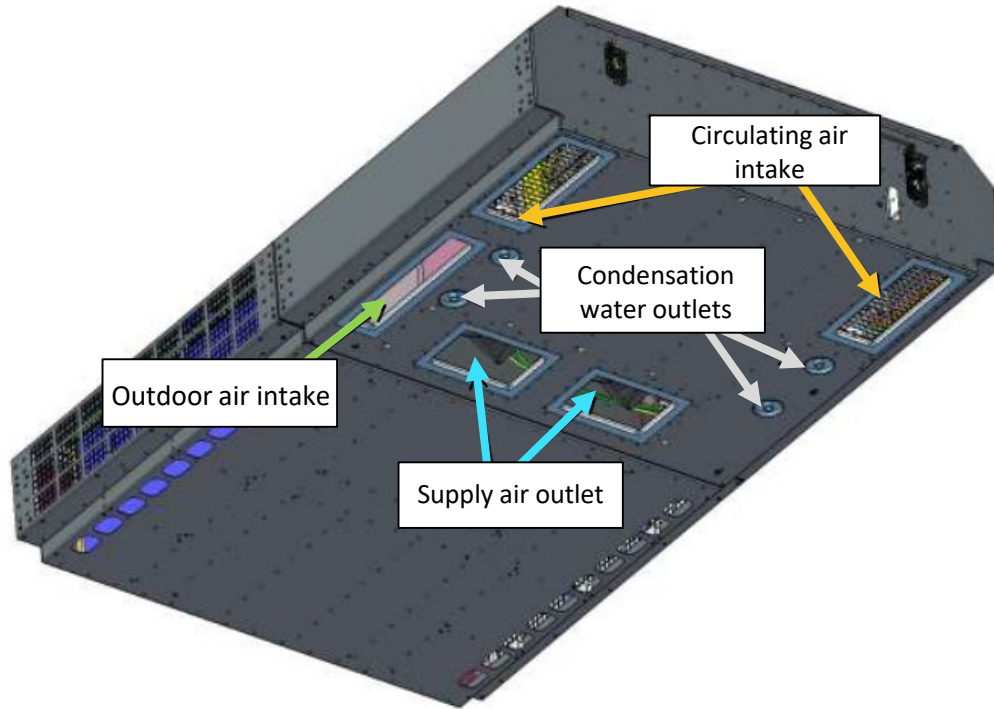
1. Cooling capacity: 28 – 36 kW (depending on emergency/non-emergency operation)
2. Heating capacity: 12 kW
3. Air supply: max. 3,500 m³ /h
4. Outside air volume: 1,200 m³ /h
5. Fresh air volume: 7 m³/h per person (if fully occupied by (2 x 170) passengers)
6. Environmental conditions:

	Operating environment (functionality):	Comfortable indoor temperature achievable:
Outside temperature with sun exposure:	-25°C to +40°C	-20°C to +35°C
Outside temperature without sun exposure (tunnels):	-25°C to +45°C, AC operative up to +55°C	-20°C to +40°C

4. Air conditioning systems for rescue trains



4. Air conditioning systems for rescue trains



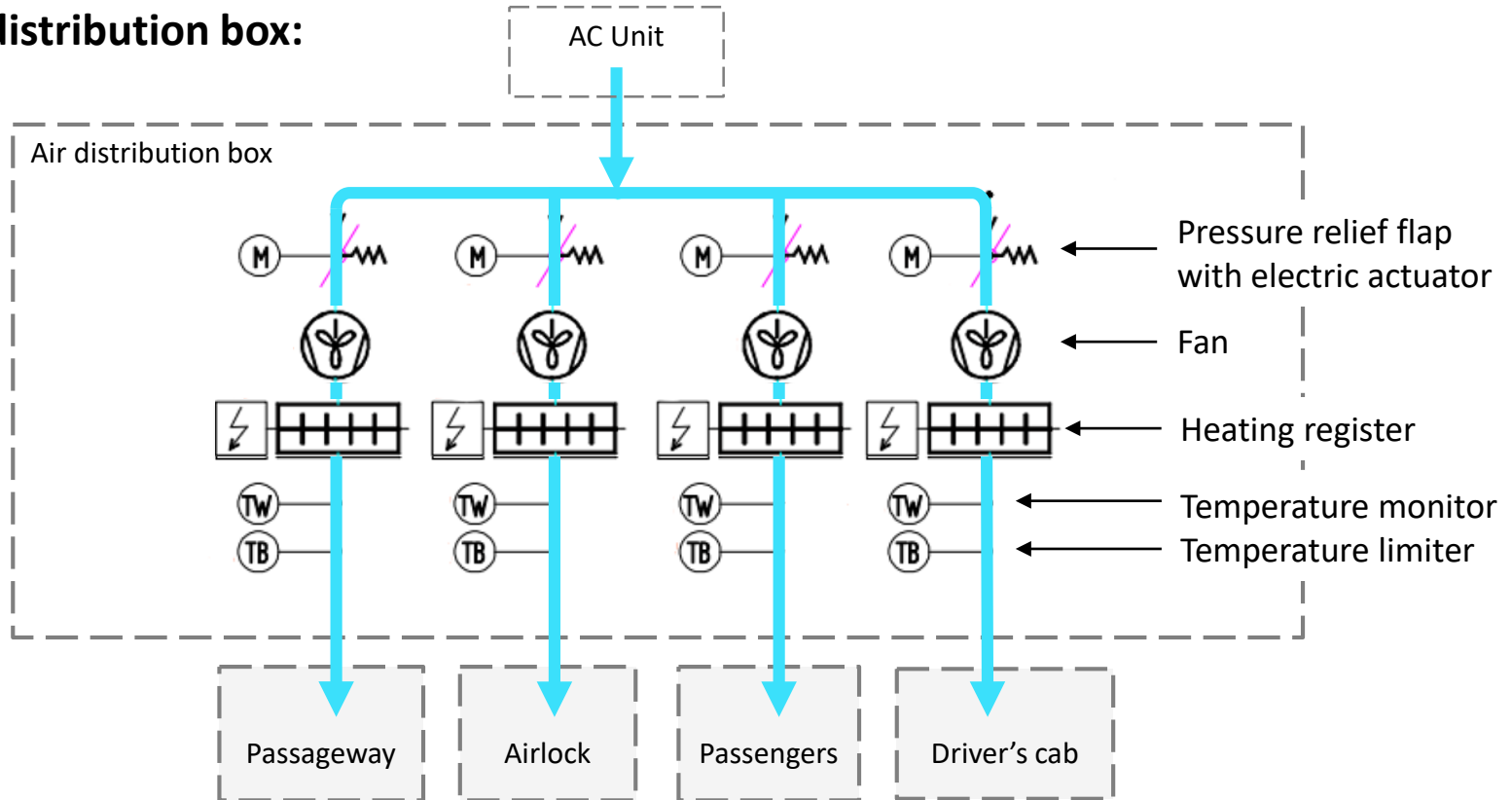
4. Air conditioning systems for rescue trains

Air distribution box:

1. Distribution of the supply air from the air conditioning unit to the various areas (4 areas per air conditioning unit)
2. Regulation of the supply air according to area and operating mode. Every zone in the vehicle can be supplied with the required air volume and air supply temperature.
3. Reheating the supply air, additional heating power for preheating

4. Air conditioning systems for rescue trains

Air distribution box:



**Thank you for your
attention!**

**Any questions or
comments?**

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