



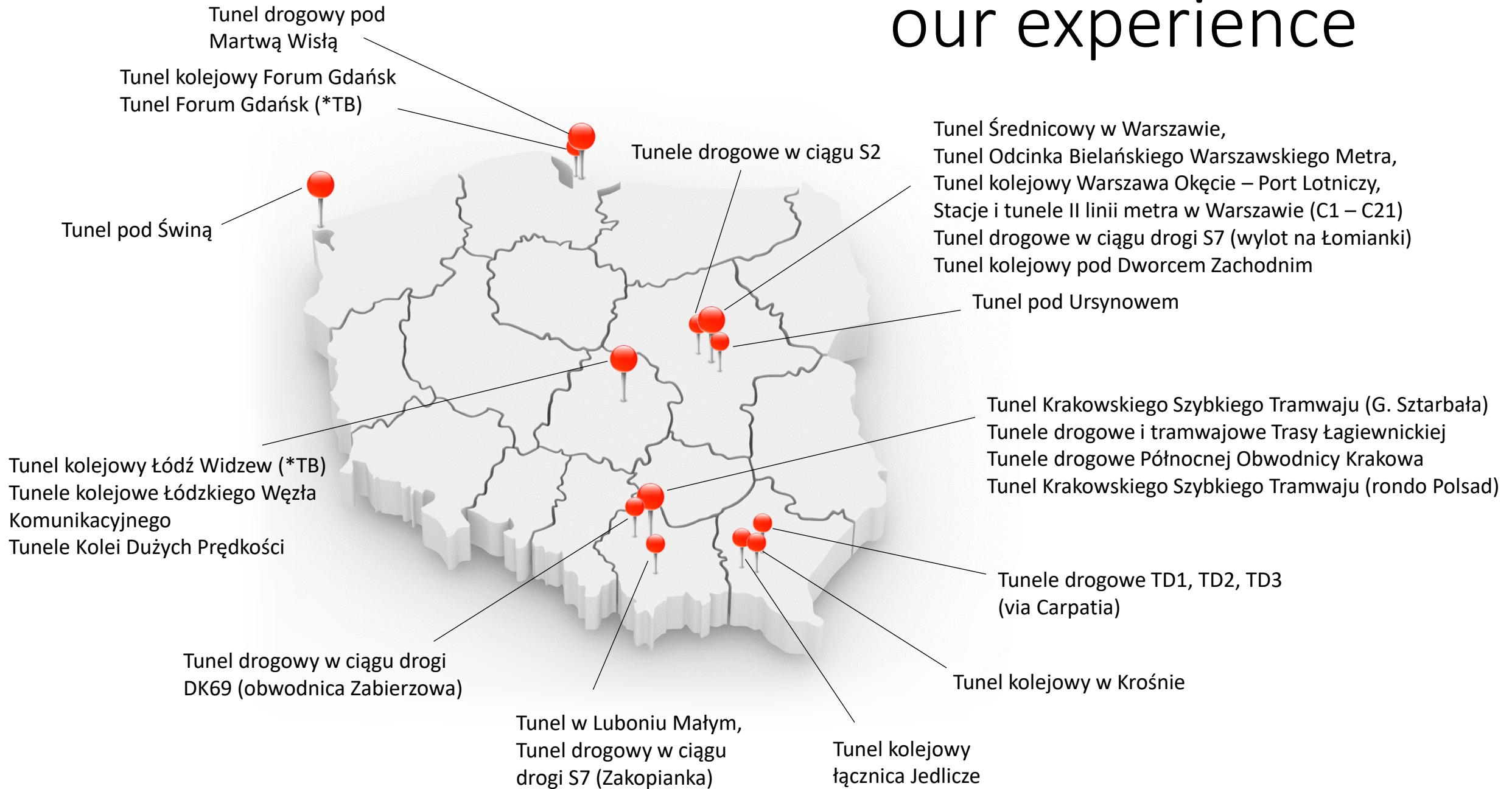
Polish experiences with tunnel smoke control

Dr Wojciech Węgrzyński, prof. ITB
Instytut Techniki Budowlanej

our experience

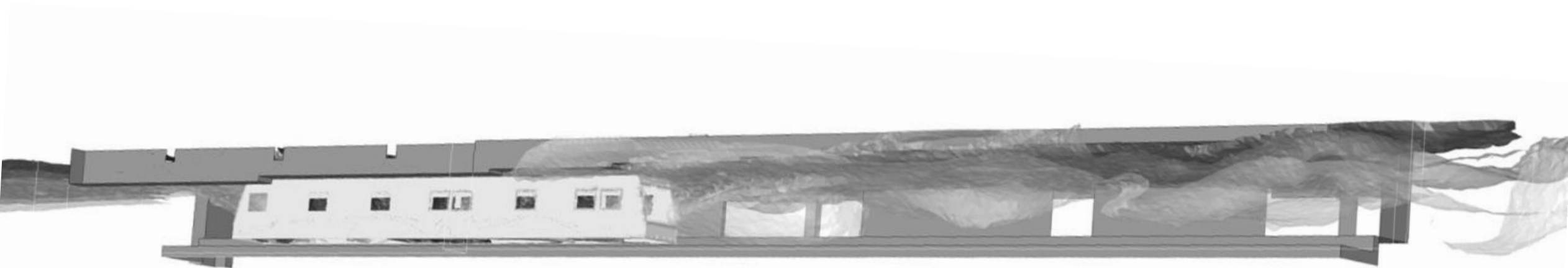


our experience



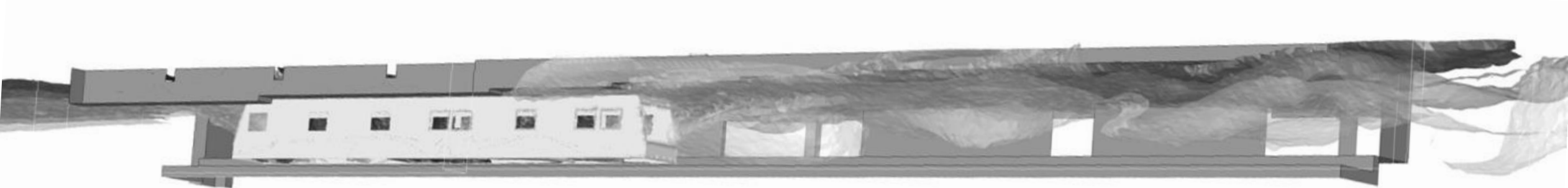
our main job - smoke control

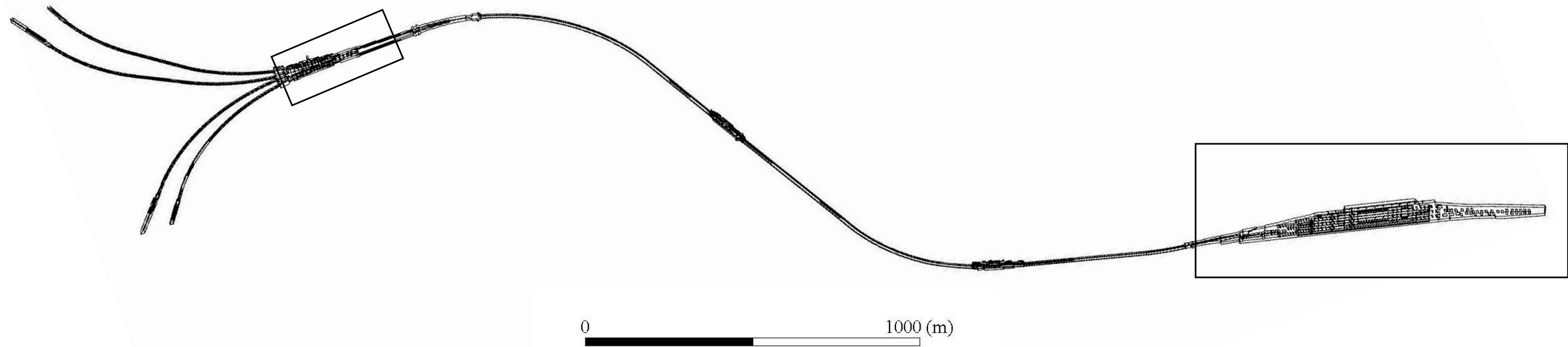
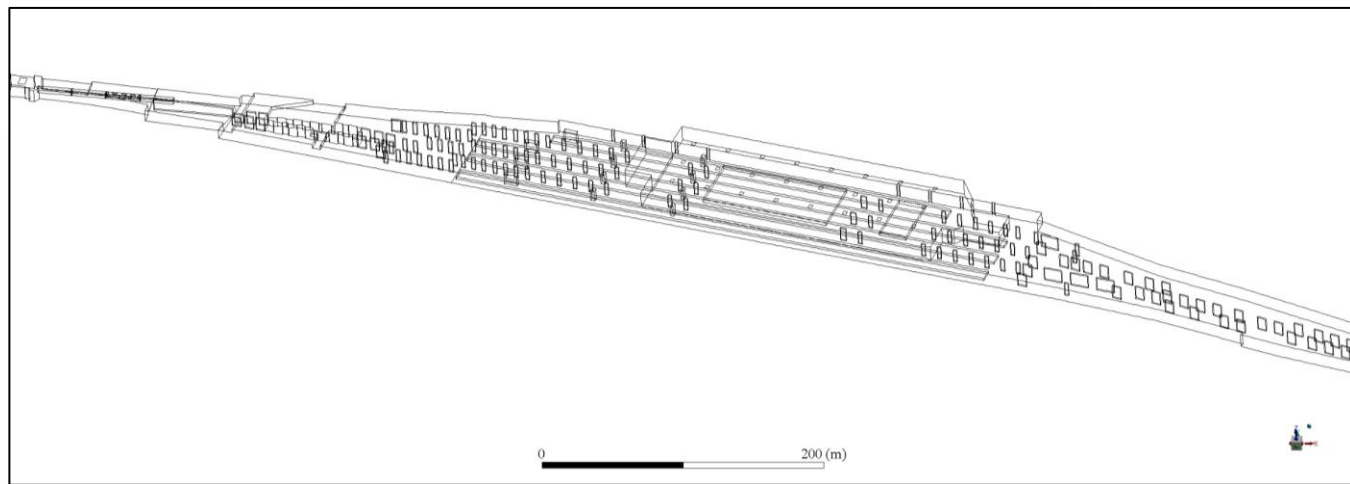
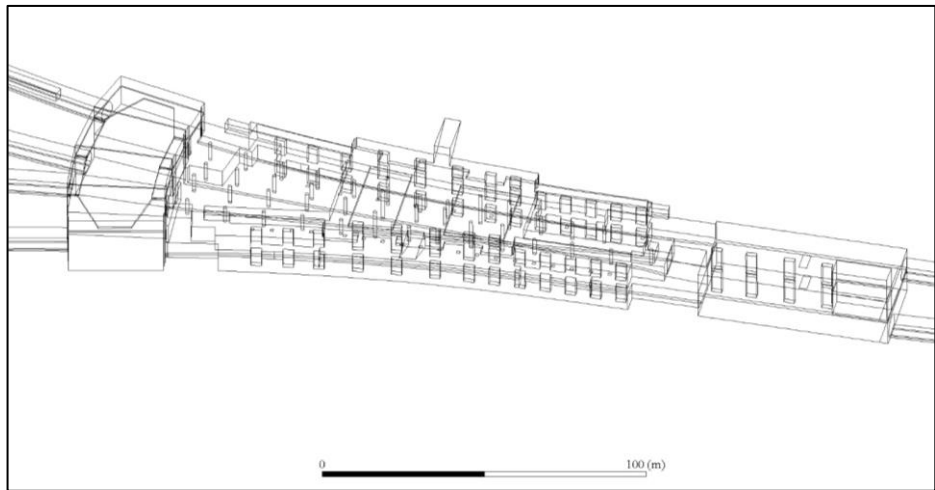
- Removes smoke and heat from the fire
- Allows to evacuate the endangered space
- Allows for succesfull firefighting operation
- Reduces the consequences of fires



our main job - smoke control

- Removes smoke and heat from the fire
- Allows to evacuate the endangered space
- Allows for succesfull firefighting operation
- Reduces the consequences of fires
- **All of the above are commonly verified with the use of CFD modeling.**





smoke control system types



Horizontal venting

Smoke removed from smoke layer



Longitudinal venting

Smoke pushed along the tunnel

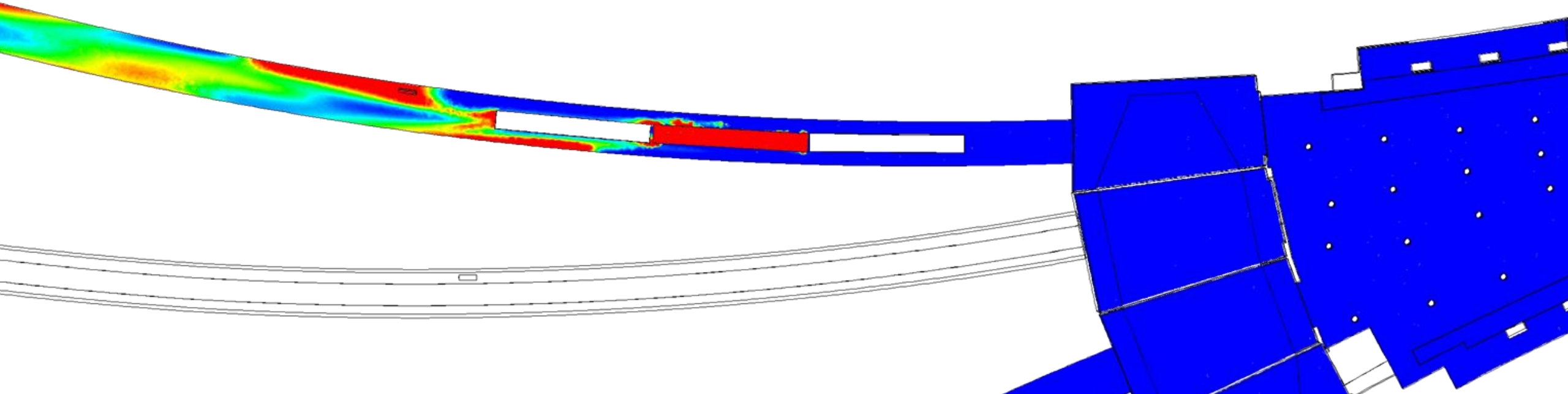
What do we want from a longitudinal system?



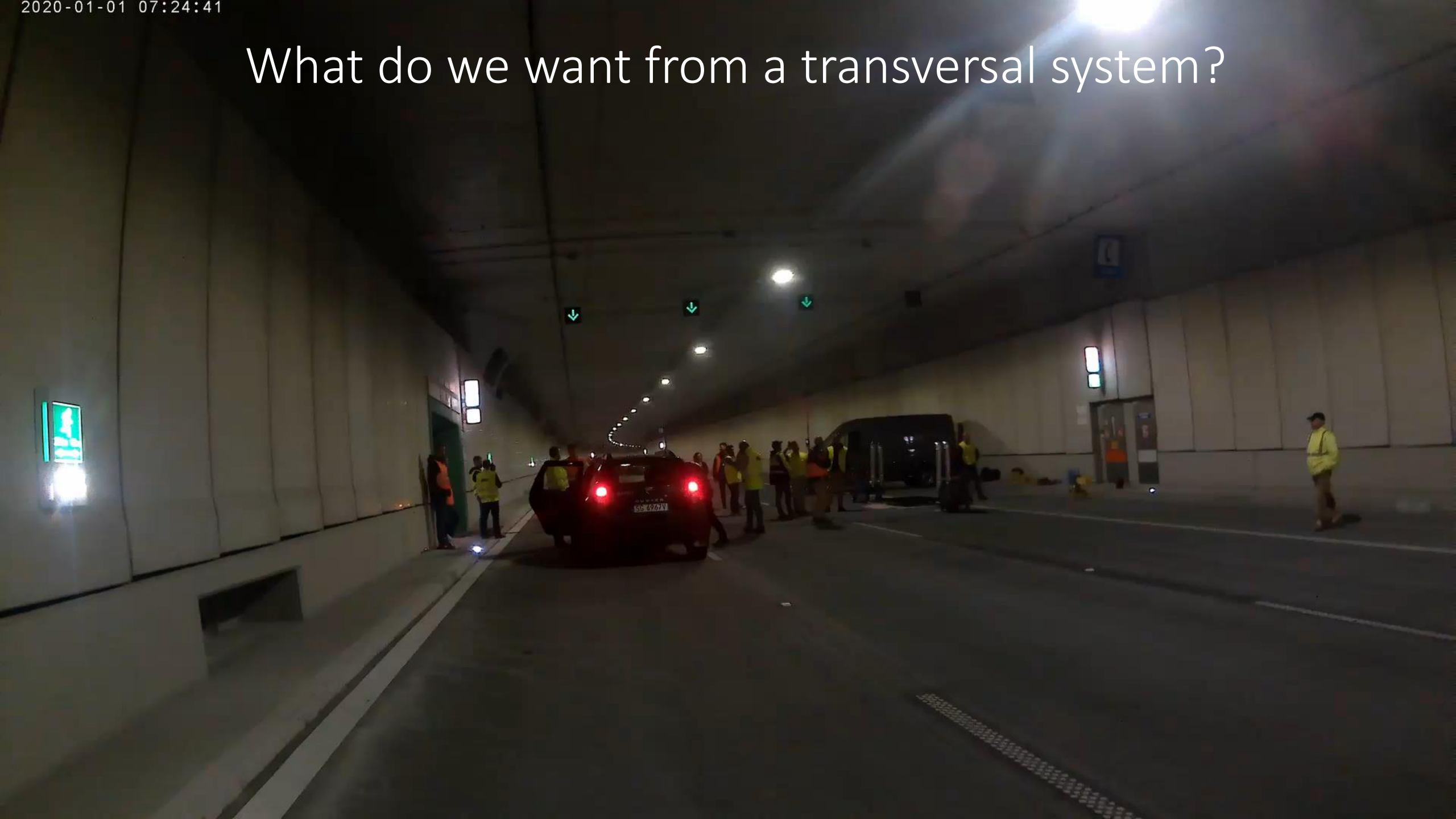
- 1** Low velocity Fire moving towards observer, a failed system
- 2** „Containment velocity” reached – no real threat from backlayering
- 3** „Critical velocity” reached, great when you need to make barbeque, but do we really need this?
(plus we make fire bigger...)

What do we want from a longitudinal system?

Moving away from oversized systems based on critical velocity at a combination of most onerous conditions (wind/fire/traffic) that form a low probability event – maybe we should move towards probabilistic and risk based design?



What do we want from a transversal system?





challenges

- mitigation of complex wind conditions that can overwhelm the system
- inability to represent initial conditions from traffic in the system design

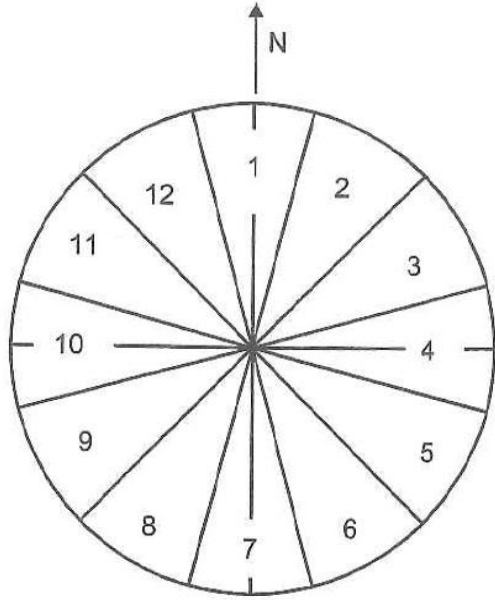
wind influence

$$\Delta P := \Delta P_{wind} \cdot A_{korekcyjna} + \Delta P_{chimneyRtm} + \Delta P_{entrance} + \Delta P_{down} + \frac{\Delta P_{exit}}{A_{korekcyjna}} + \Delta P_{veh} + \Delta P_{fire} + \Delta P_{atm} = 111 \text{ Pa}$$

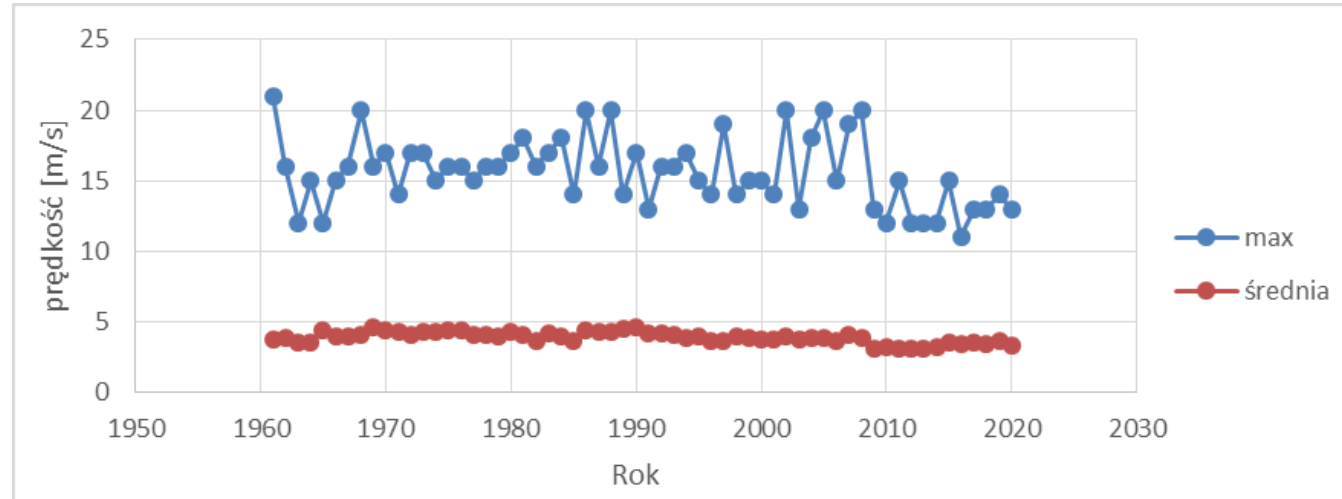
Wind was included in the design stage by introducing jet-fan systems in the design, but there is no good method to define their momentary mode of operation.

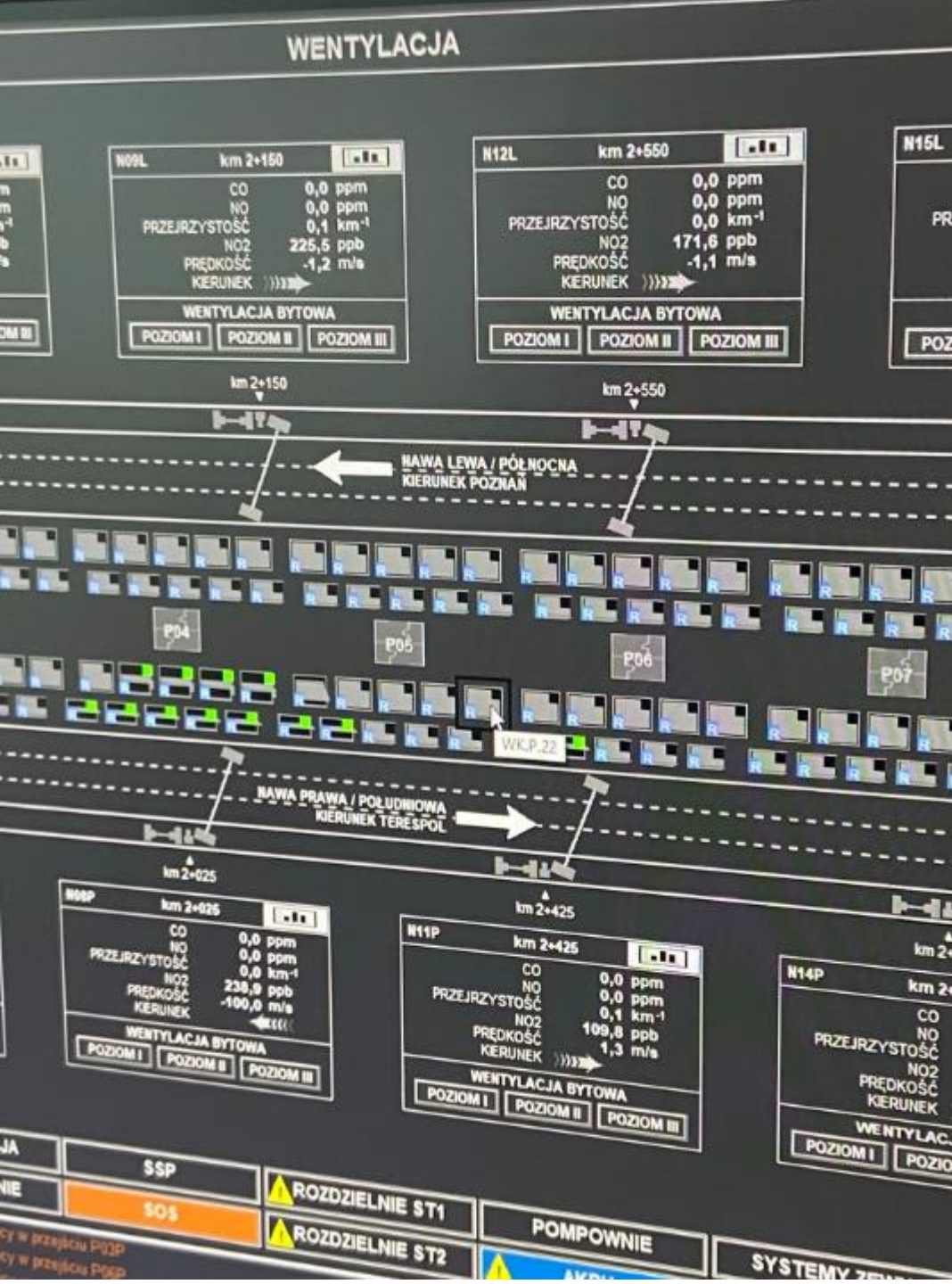


wind influence - solution



Sektor	Grupa prędkości								
	1	2	3	4	5	6	7	8	9
cisze	3.8051								
1		0.2464	1.3364	1.5509	0.6191	0.1507	0.0256	0.0018	
2		0.2120	1.3955	1.5228	0.5422	0.1070	0.0085	0.0004	
3		0.3115	1.9872	1.8358	0.6582	0.1235	0.0098	0.0004	
4		0.5502	2.9316	2.6438	1.1587	0.3253	0.0580	0.0071	
5		0.9605	4.6978	3.1951	1.6068	0.5703	0.1199	0.0156	
6		1.1935	4.3870	2.2297	0.5933	0.1019	0.0069	0.0007	
7		1.1948	3.6223	1.5136	0.3792	0.0528	0.0067	0.0007	
8		0.8454	2.6088	1.5047	0.6468	0.2125	0.0330	0.0047	
9		0.8494	3.5302	2.6212	1.3834	0.5117	0.1159	0.0294	0.0018
10		0.8156	4.6456	5.4171	3.8261	1.7894	0.5204	0.1926	0.0279
11		0.5135	2.9155	3.0127	1.8108	0.7183	0.2232	0.0633	0.0156
12		0.2936	1.7800	1.8750	0.8963	0.3607	0.0992	0.0218	0.0031
zmiennych		1.1052	1.5685	0.0149	0.0004				





wind influence - solution

Because we knew exactly what velocity in the tunnel is introduced by every particular wind velocity/direction combination (either measured or calculated from estimated portal coefficients), we could have designed individual scenarios of operation of the jet-fans for any wind speed that will occur.

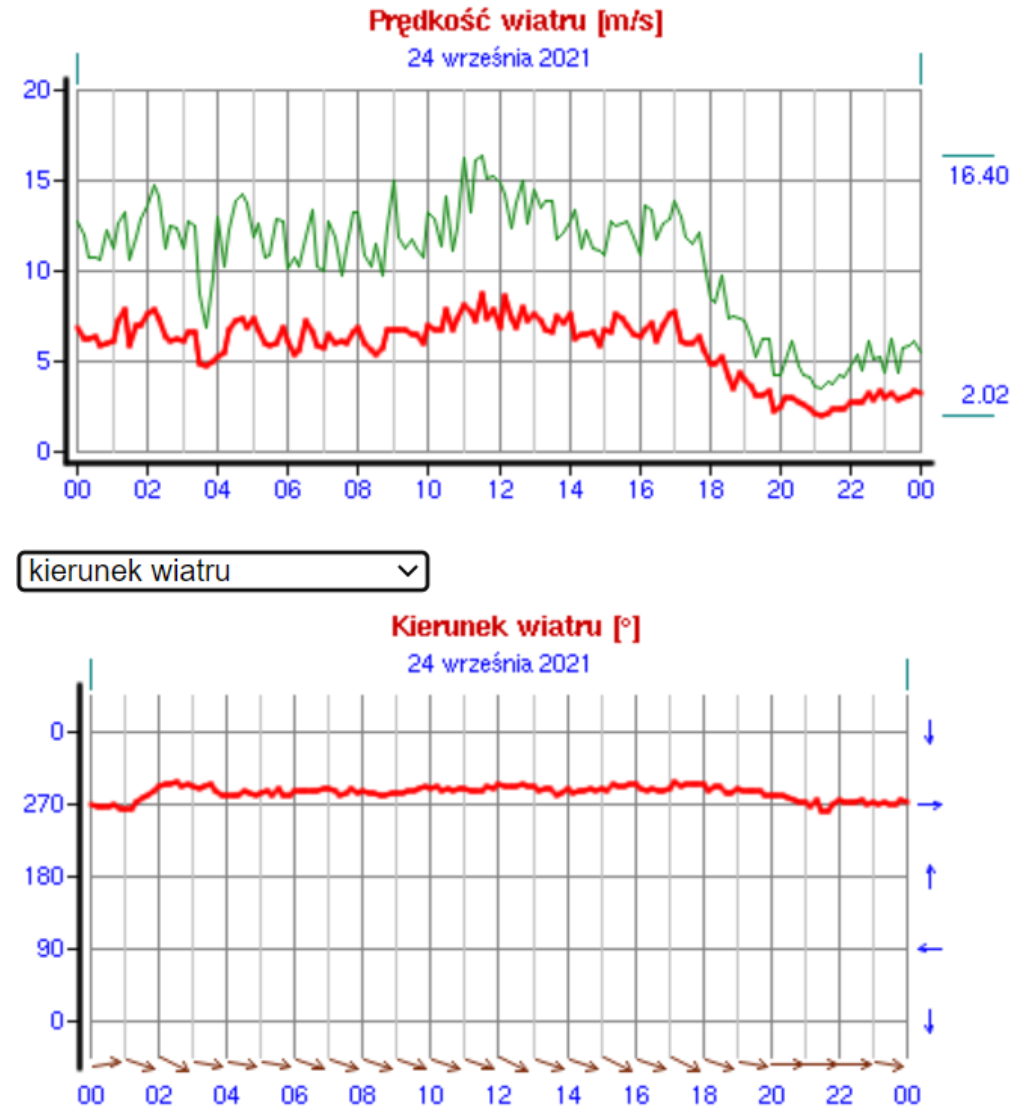
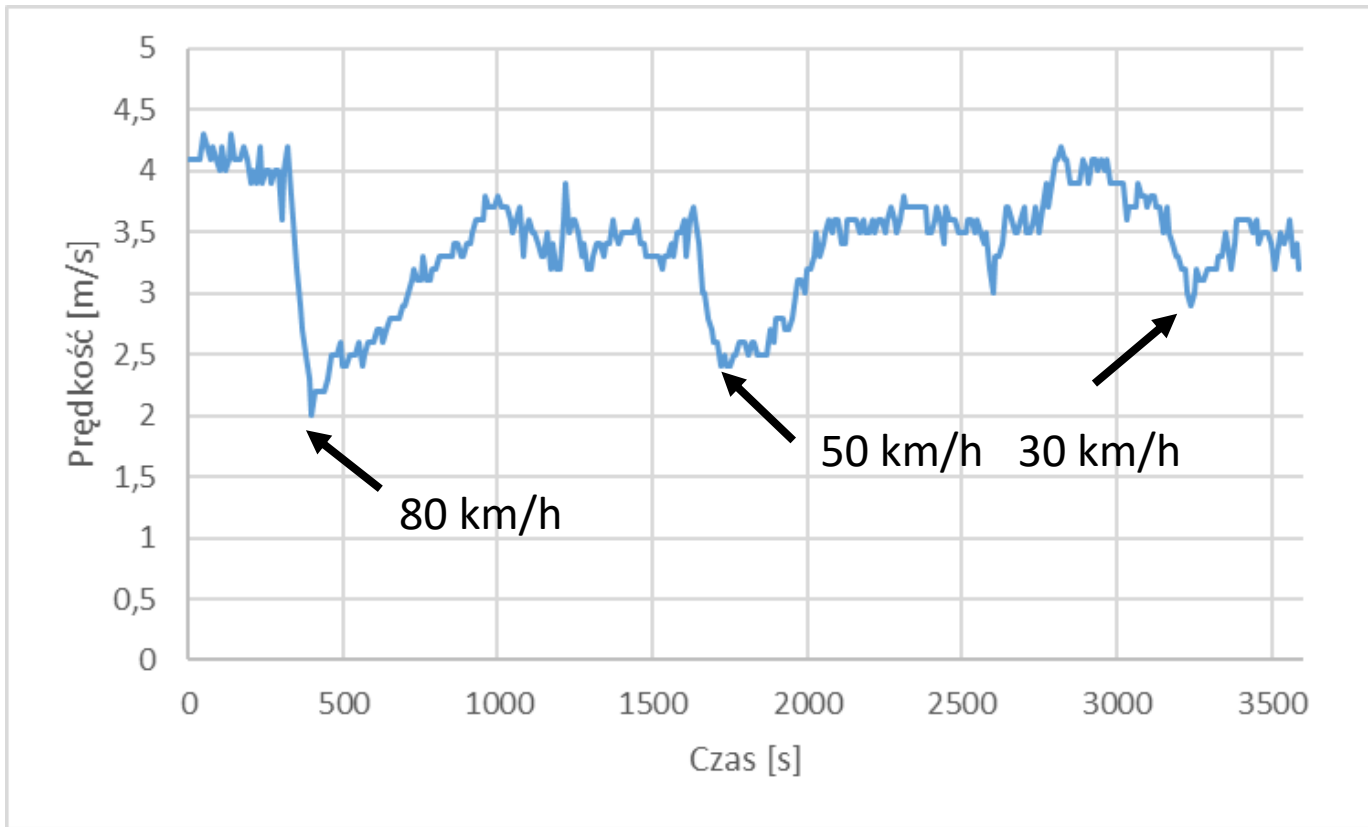
Can vehicles stop wind?



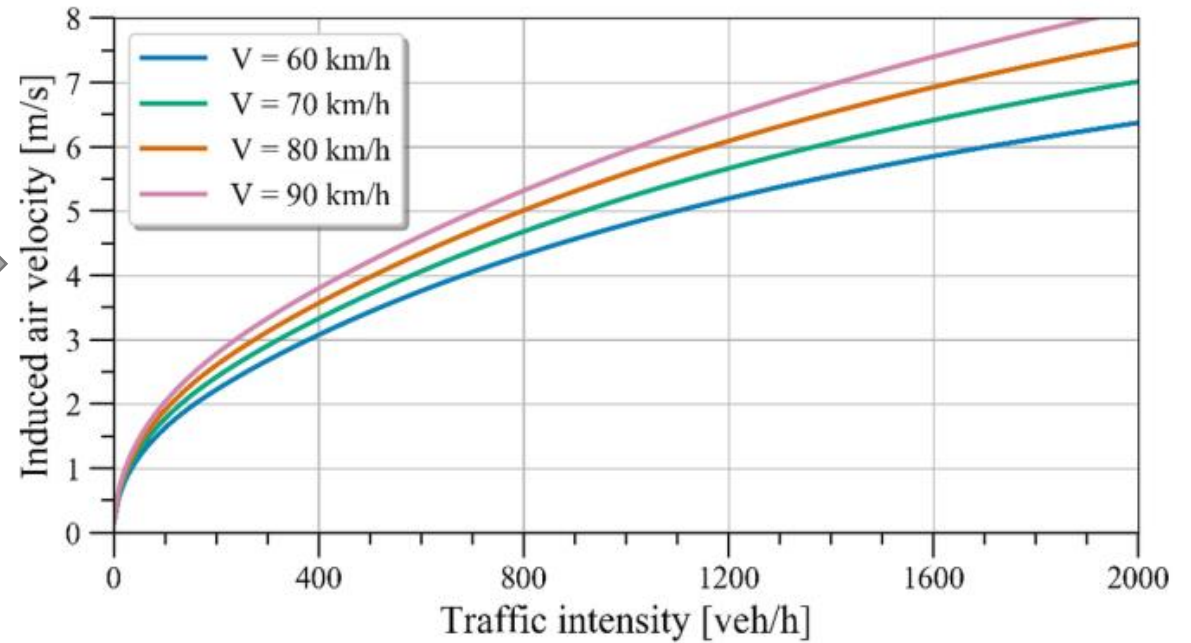
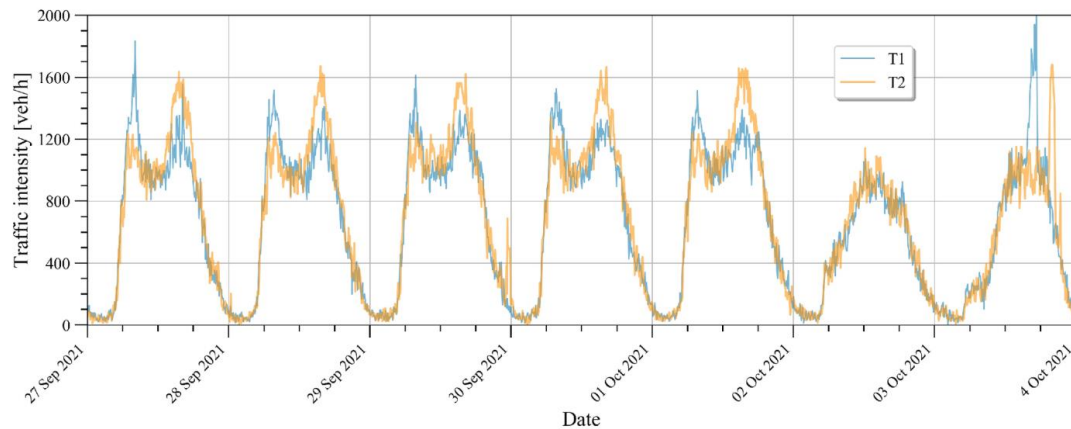
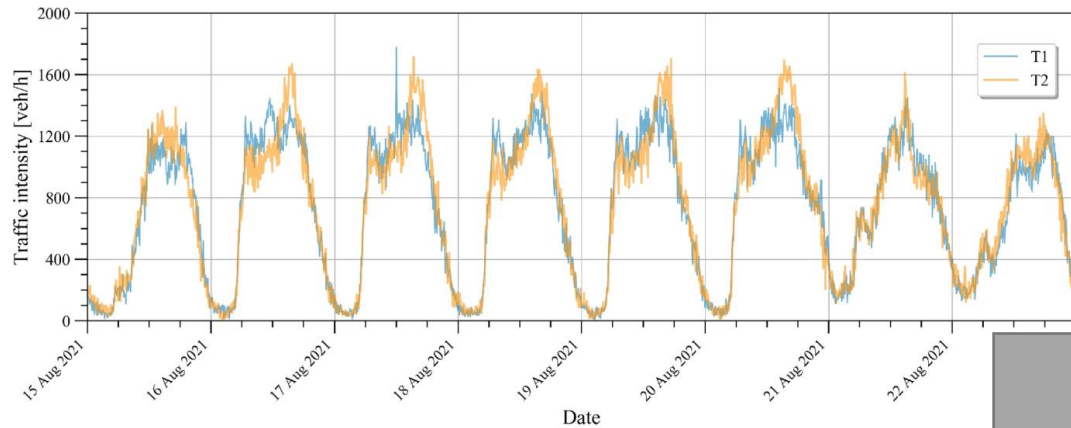
Can vehicles stop wind?



Can vehicles stop wind?



Can vehicles stop wind?



a)

Fig. 13. Traffic intensity for both periods.

Król A., Król. M., Węgrzyński W., 2022. A study on airflows induced by vehicle movement in road tunnels by the analysis of bulk data from tunnel sensors. (in review)



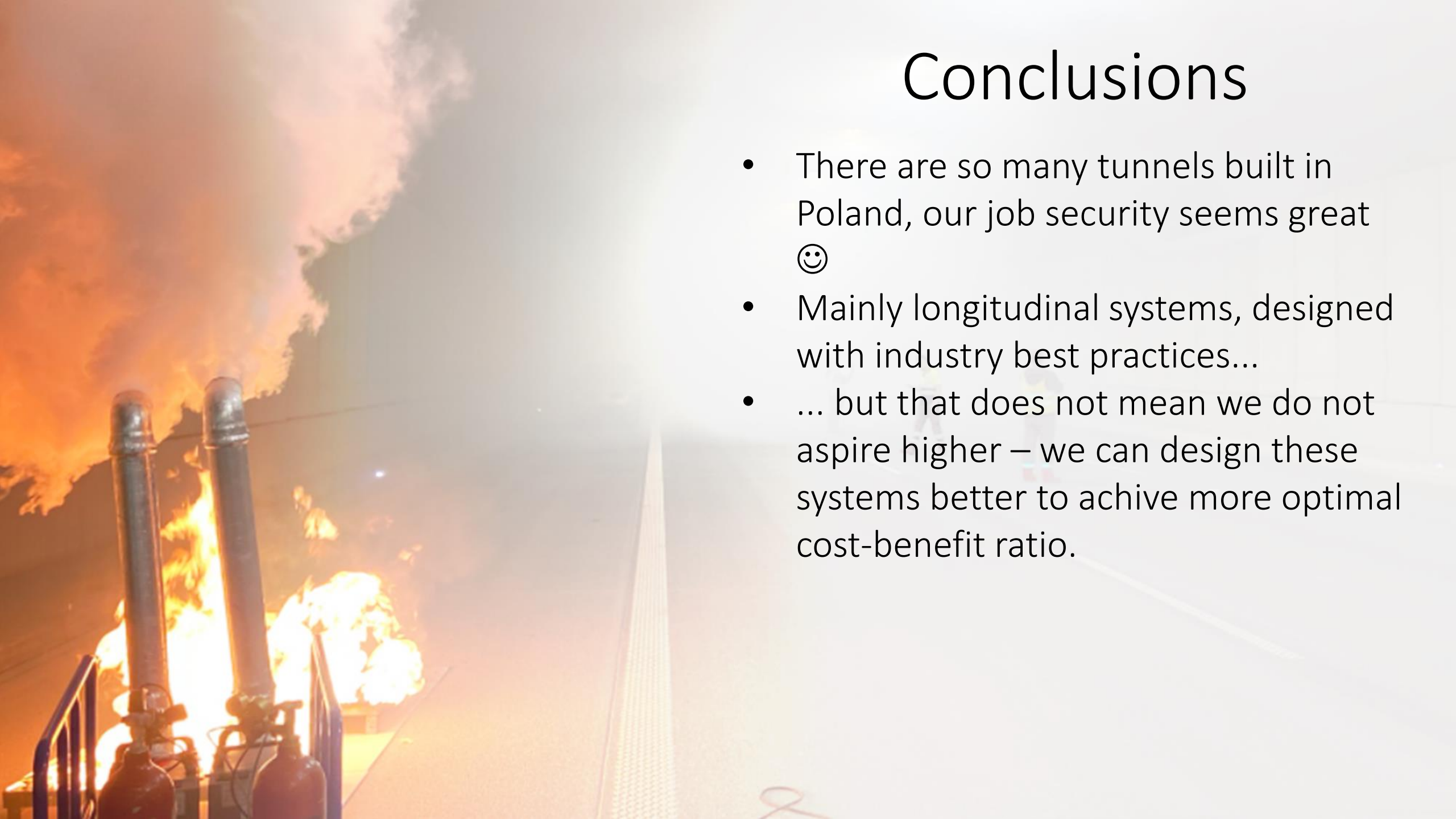
Our little innovation

Every fire in the tunnel starts with a vehicle that has stopped.

Using AID and SCADA systems we have programmed an additional sanitary mode operation mode, which is like the fire mode operation, that is triggered once a vehicle stops in the tunnel. This allows to significantly shorten the time for the system to operate in full capacity (as fire detection may take some time...)

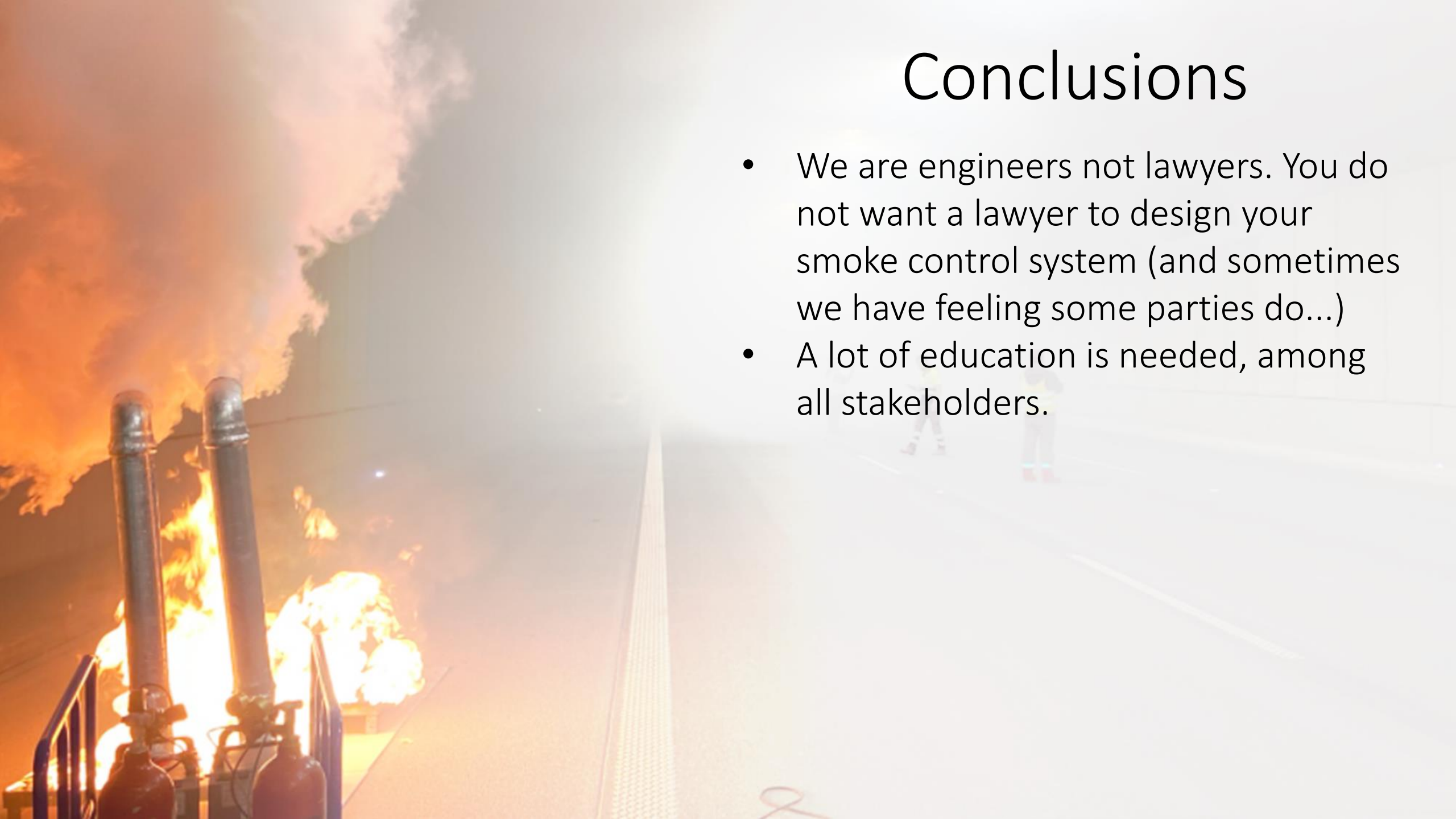
Conclusions

- There are so many tunnels built in Poland, our job security seems great 😊
- Mainly longitudinal systems, designed with industry best practices...
- ... but that does not mean we do not aspire higher – we can design these systems better to achieve more optimal cost-benefit ratio.



Conclusions

- We are engineers not lawyers. You do not want a lawyer to design your smoke control system (and sometimes we have feeling some parties do...)
- A lot of education is needed, among all stakeholders.



Thank you!



FireScienceShow.com

