Three-stage Closed-circuit Windtunnel @ ESRIG

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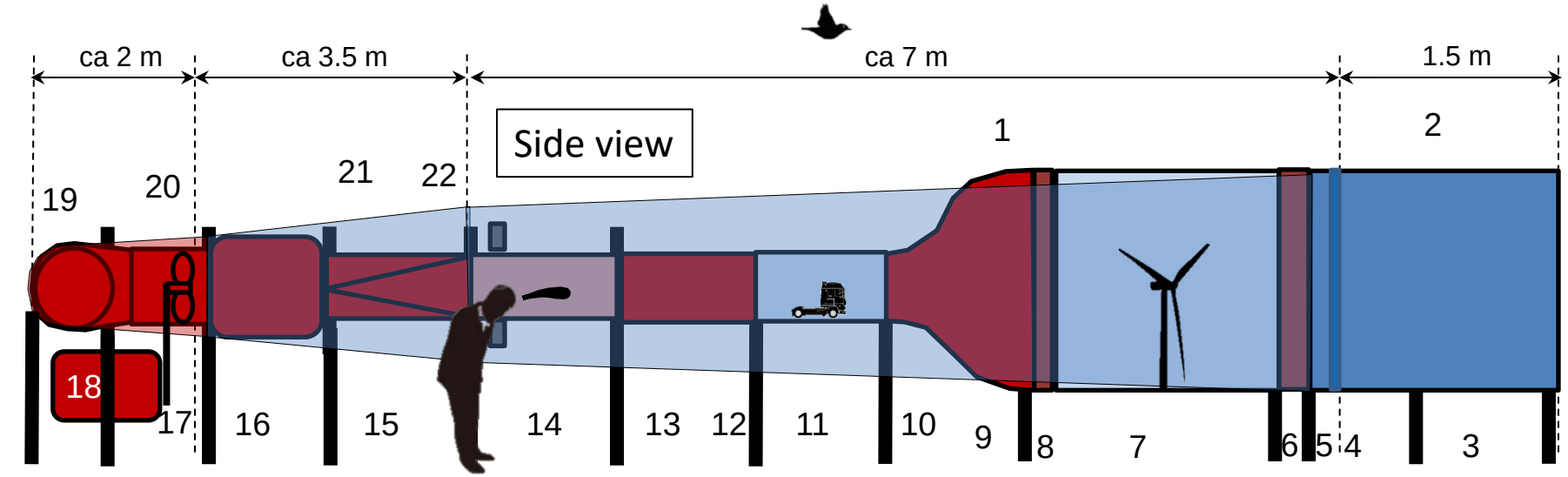
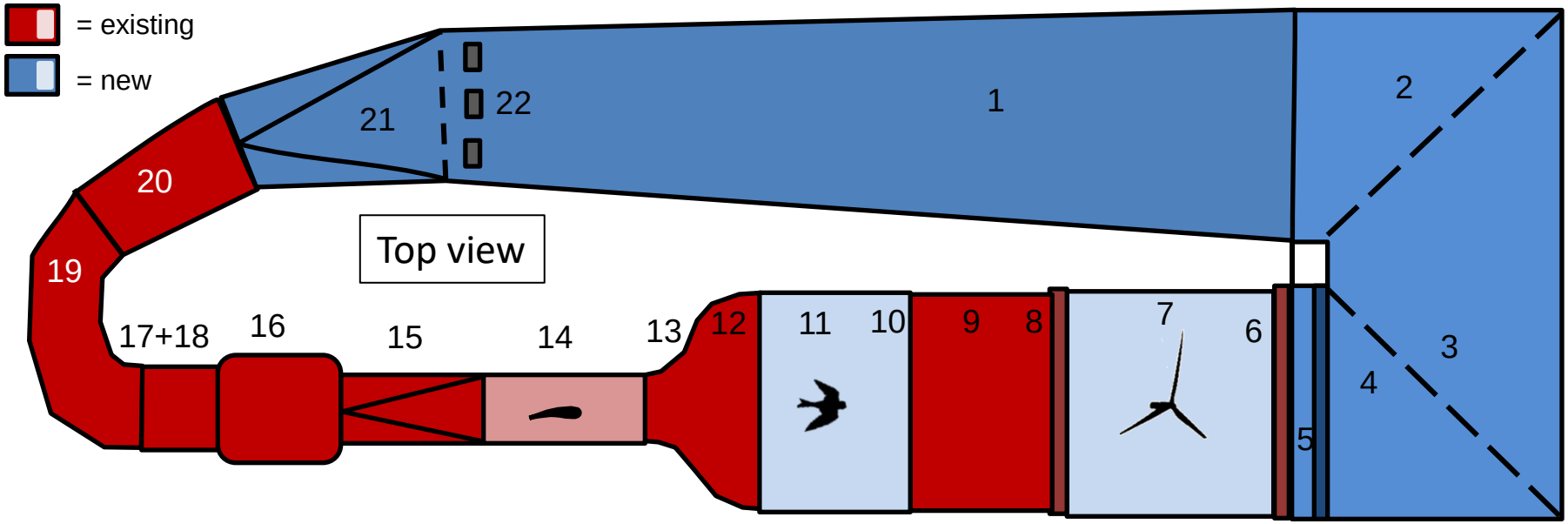
The Energy & Sustainability Research Institute Groningen, Faculty of Science & Engineer, University of Groningen, owns a closed-loop windtunnel which is housed in the Nuclear Physics building (KVI), Zernikelaan 25 (Campus Groningen). This windtunnel is originally built by VFW-Fokker around 1965 at their Bremen branch for the Dept. Of Aerodynamics of the Hochschule Bremen. The construction materials used are (ply-)wood, polyester, steel, brass and aluminium, the main construction is wood-based. After it became obsolete in 2015, the aerodynamics dept. was reluctant to take it down because it was such a high-quality tunnel. An arrangement then was made to take it apart in transportable pieces and move it to Groningen. The aim was to re-install it there in its former glory and beyond, for use in Biomimetics- and Energy-related ESRIG research.
Since then it has been re-erected in the KVI and on top of that it has been modified to include 2 extra measurement sections as well as closing the tunnel to reconstruct it from an open tunnel that breathed outdoor air to a closed-loop tunnel, that can also be used for modern techniques such as Particle Image Velocimetry (PIV). The first settling chamber has been extended with a 1.5 m long polycarbonate transparent section (1.40x1.40 m across) for low-speed testing in rel. low quality air flows. After the subsequent vertical contraction cone a second 1.5 m long polycarbonate transparent section (0.5x1.4 m across) has been added for medium speed and medium quality air flow testing. The original 1 m long measuring section (0.5 x 0.4 m across) is situated downstream of the medium speed section and the horizontal contraction cone and has been retained for high-speed testing in high-quality air flows. The respective max. flowspeeds in the respective subsequent sections are (ca): 5 m/s = 18 km/h, 15 m/s = 54 km/h, and 45 m/s = 162 km/h, this last speed corresponding to more than 12 Beaufort: Hurricane F2.
At the in- and outflow frames of the large and medium sized sections metal wire netting has been installed to allow experimental work with live birds. At the moment the large section is used for low-speed testing of experimental small wind turbines, the middle speed section is used for medium-speed testing of truck models, and the high-speed section is used for wing/blade profile testing, of course experimental tests are performed only in one section at a time.
The wind machine is based on a 25 kW 3-phase electrical engine that is regulated by setting the frequency to the nearest 0.1 Hz. The high-speed section is provided with a pitot-tube velocimeter allowing speed readings for the fast sections from which the speeds in the other sections can be calculated using the volume flow per cross section ratio.
In the main diffuser, a heat exchanger has been installed with a thermostatic valve that keeps the air in the tunnel at a constant temperature of ca 20°C or any other desired temperature between 15 and 26 degrees.

The costs for operation for external users are 75 €/hr (600 €/day), including basic operational assistence. An additional full-time operator is available at extra costs. The tunnel can be used for smoke-visualisation or for laser-based techniques such as Particle Image Velocimetry (all available but at extra costs).

ESRIG/*VFW-Fokker* Triple Section Windtunnel

Closed, with 3 exp. sections: - LS (5 m/s), MS (15 m/s) and HS (45 m/s)



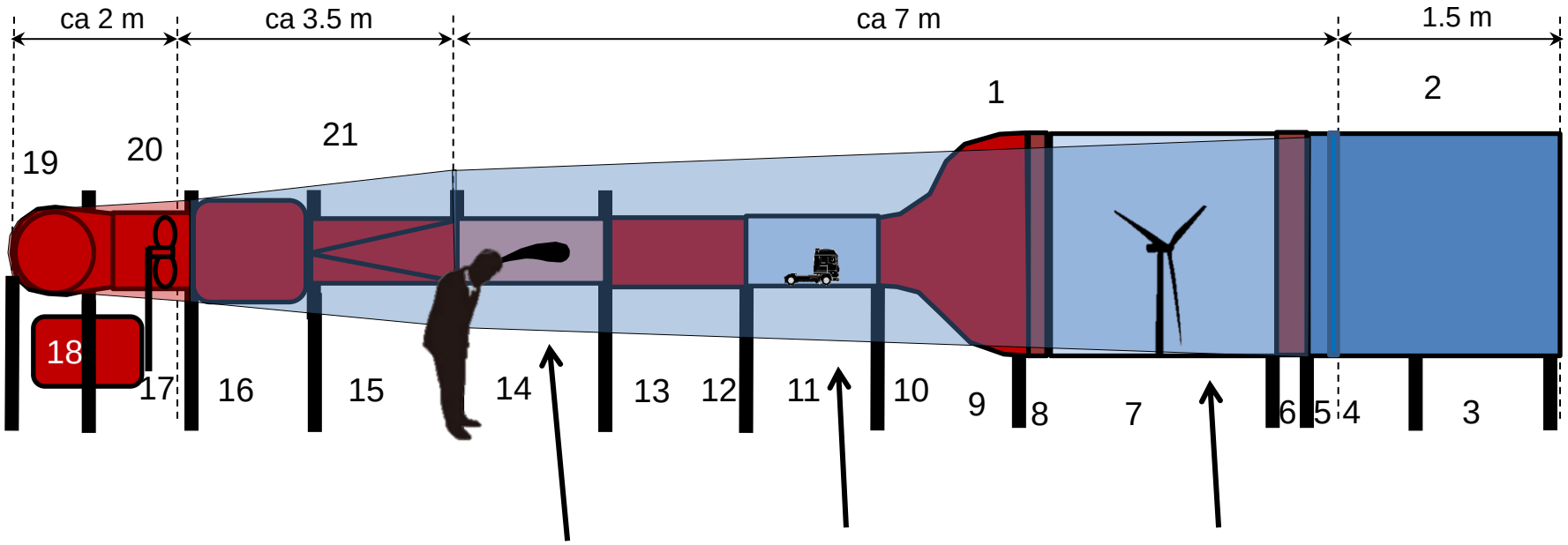


= existing

= new

Closed 3-stage configuration

side view



EXP foils + small objects 0.4 x 0.5 m v_{max}= 45 m/s

EXP Birds + med. size objs. 1.4 x 0.5 m v_{max}= 15 m/s

EXP turbines, birds, large objs. 1.4 x 1.4 v_{max}= 5 m/s

LEGEND:
1 = Main diffuser = increase in X + Y from 1.0 -> 1.6 m in size
2 = 1st corner = 1.6 x 1.6 m entrance, 90° turn, corner vanes
3 = 2nd corner = 1.6 x 1.6 m exit, 90° turn, corner vanes
4 = After corner = honeycomb for flow straightening, 1st contraction -> 1.4 x 1.4 m
5 = short ‘settling chamber’
6 = mesh/netting
7 = 1st exp/flight section = 1.4 x 1.4 x 1.5 (hxbxl) from 8 mm polycarbonate
8 = mesh/netting
9 = Y-contraction = from 1.4 x 1.4 -> 1.4 x 0.5 => ca factor 3 contraction
10 = mesh/netting
11 = 2nd exp/flight section = 1.4 x 0.5 x 1.2 (bxhxl) from 8 mm polycarbonate
12 = mesh/netting
13 = X-contractor = from 1.4 x 0.5 -> 0.4 x 0.5 => ca factor 3 contraction
14 = foil aerodynamics measurement section = 0.5 x 0.4 x 1.0 m (hxbxl)
15 = square -> round Ø = 0.63 m diffuser
16 = silencer
17 = driving fan Ø = 0.63 m
18 = driving 3-phase engine 25 kW var. frequency (I-max=45A/phase)
19 = return bend Ø = 0.63 m
20 = diffuser from Ø = 0.63 -> Ø = 1.00 m
21 = diffuser from Ø = 1.00 -> square 1.0 x 1.0 m
22 = heat exchanger incl. thermostat system + grounding to remove static charge