

# RTRI's Large-Scale, Low-Noise Wind Tunnel

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RTRI's large-scale, low-noise wind tunnel was constructed for research on various aerodynamic and aeroacoustic issues for the Shinkansen and other high-speed railways. This wind tunnel has an open test section and a closed test section (Figs.1, 2), and has the following features (Table 1).

## 1. Large test sections and high wind velocity

### • Open test section (Fig. 3)

The open test section is chiefly used for testing aeroacoustic issues, such as the aerodynamic sound produced by a model. The cross-section of the nozzle is 3.0 m in width and 2.5 m in height, and the length of the test section is 8.0 m. The maximum wind velocity is 400 km/h. The model can be set on a support table (turntable) between the nozzle and the collector. This test section permits testing of an actual pantograph.

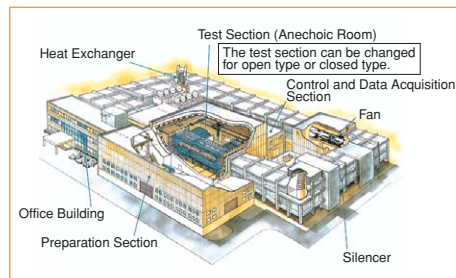
### • Closed test section (Fig. 4)

The closed test section is used for testing aerodynamic issues, such as aerodynamic drag, the aerodynamic characteristics of the model, the flow around the model, and other issues. The closed test section is 5.0 m in width, 3.0 m in height, and 20 m in length. The closed test section is composed of a front part (6.5 m in length) and a rear part (13.5 m in length). The front part is equipped with a boundary suction system and a turntable with a 6-component balance, and the rear part with a boundary suction system, a moving belt ground plane, and a turntable. These two parts are joined together to form the test section. The maximum wind velocity is 300 km/h. This test section permits testing of an actual pantograph and an actual automobile.

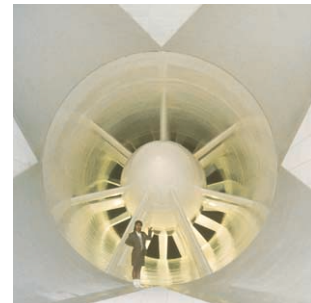
## 2. An extremely low background noise level 75.6 dB at wind velocity of 300 km/h (Fig. 5)

**Table 1. Specifications**

Item	Specifications	
Tunnel	Göttingen type single return wind tunnel	
Test sections	Open type	Closed type
Width and height	3.0 m(W) × 2.5 m(H)	5.0 m(W) × 3.0 m(H)
Length	8 m	20 m
Maximum wind velocity	400 km/h	300 km/h
Contraction ratio	16:1	8:1
Uniformity of wind velocity	Under ±0.7 % at 324 km/h (90 m/h)	Under ±0.4 % at 288 km/h (80 m/h)
Turbulence intensity	Under 0.2 % at 360 km/h (100 m/h)	Under 0.2 % at 198 km/h (55 m/h)
Background noise level	75 dB(A) at 300 km/h (83.3 km/h)	—
Main instruments	Sound level meter Linear array microphone Parabola microphone apparatus Ellipse microphone apparatus	6-component balance with turntable 6-component wire balance Pressure scanning system
Main accessories	Anechoic room (20 m(W) × 22 m(L) × 13 m(H)) XYZ traversing gears in anechoic room Support table with turntable	Moving belt ground plane (2.7 m(W) × 6.0 m(L)) Boundary layer suction system XYZ traversing gears in closed section
Overall dimensions	Length:94 m, Width:42 m, Height:10 m, Total path length:288 m	
Fan	Diameter:5 m, Blades:Moving blades:12, Stator blades:17 Rotation:590 rpm (Maximum), Traction motor:7MW, Three phase induction motor	



**Figure 1.** RTRI's large-scale low noise wind tunnel



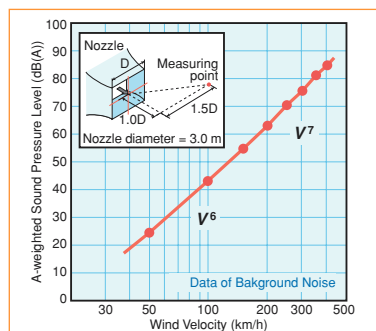
**Figure 2.** Fan



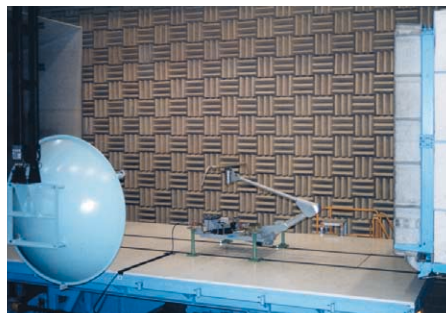
**Figure 3.** View of open test section



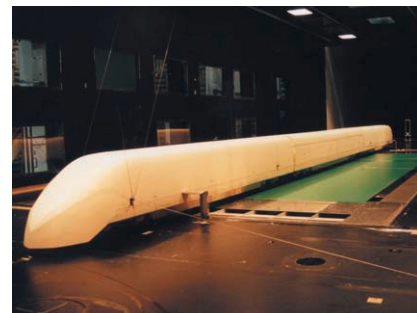
**Figure 4.** View of closed test section



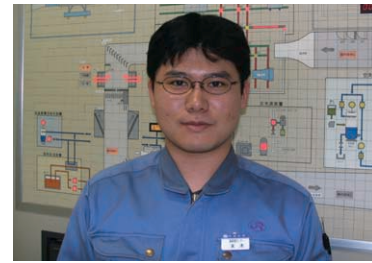
**Figure 5.** Background noise level



**Figure 6.** Aeroacoustic test of pantograph using ellipse microphone apparatus



**Figure 7.** Vehicle model supported with 6-component wire balance



The aerodynamic sound produced by a model in the open test section

can be distinguished accurately in a large anechoic room 20 m wide, 22 m long, and 13 m high. In addition, by using a traversing gear that moves over the whole area of the anechoic room, it is possible to measure the sound field widely (Fig. 6).

## 3. A high speed moving belt ground plane

The moving belt ground plane of 2.0 m in width and 6.0 m in length is capable of running at a maximum speed of 220 km/h. By moving the belt of the ground plane at the same speed as the wind velocity, it is possible to simulate the flow under the floor of the vehicle more accurately. The model is supported with a 6-component wire balance installed in the ceiling of the closed test section (Fig. 7).

## 4. Measuring devices

The wind tunnel is provided with various measuring instruments, such as omnidirectional microphones, directional microphones, 6-component balance and pressure scanning system, allowing for various types of measurement—sound, aerodynamic force, and pressure.

RTRI's large-scale, low noise wind tunnel having the above features can be applied to basic research and technical development for not only railways but also other fields such as automobiles and wind engineering. This wind tunnel was put into operation in 1996 and has been used for basic research and technical development on aeroacoustic and aerodynamic issues for high speed railways, and contributed to the development of the environment-friendly railways ever since.