The climatic wind tunnel in Vienna, Austria

Tests on rail and road vehicles under extreme climatic conditions

History:

A vehicle testing station for climatic tests has been in operation on the premises of the former Arsenal since June 1961. It sprang from a joint project involving the Office for Research and Experiments (ORE), the International Railway Union (UIC) and the Austrian Federal Government. The latter had also contributed the necessary construction site, which offered the unique opportunity to combine the new facility with the existing Test and Research Institute for Heating and Refrigeration Technology and Fluid Mechanics based at the Vienna Arsenal. Numerous European railway authorities and companies as well as the Federal Government were willing to finance the facility on a joint basis. Construction work on the new vehicle testing station, consisting of one static and one dynamic chamber (climatic wind tunnel) began on 18 September 1958. The new facility was put in operation on 22 June 1961.
In its more than 40 years of operation it was modernised in 1973/74 in order for it to continue to meet the requirements of modern testing. In its original configuration, each of the two chambers produced temperatures from – 40° to + 50°C, the dynamic chamber additionally generating wind speeds of up to 120 km/h at - 15°C. After several upgrades the temperature range extended from - 50°C to + 50°C and the air speed simulating the travelling speed of the vehicle was increased to 250 km/h accompanied by a triple increase in cooling power.
The vehicle testing station operated at the limits of its capacity for several years, and the end of its technical service life finally required the facility to be completely rebuilt in a new location. The Province of Vienna and the Federal Government readily advanced considerable funds in order to retain the technical know-how and expertise gained over decades – after all, Vienna boasts the only climatic wind tunnel for rail vehicles worldwide. Logistics and transport technology will be the key areas of the new Technology Centre, which is currently being built on the so-called Pauker premises in Vienna's 21st District. It was in this location that the foundation stone for the new climatic wind tunnel (CWT) was laid in early March 2001. The facility was completed on schedule at the end of 2002.

Project structure:

Since the investment was too high for the individual rail vehicle manufacturers and involved a long refinancing period, the “Vienna climatic wind tunnel” project was carried out in the framework of a Public Private Partnership. In this scheme the public sector and private firms joined forces to implement the project. The Federal Government and the Municipality of Vienna contribute equity capital and loans to the project, thus ensuring long-term financing. The balance of the investment costs of 65 m € is covered by outside capital.
The public partner, the government-owned Railway Infrastructure Financing Company (SCHIG Schieneninfrastrukturfinanzierungs-Gesellschaft m.b.H.) founded a subsidiary company, Rail Test & Research GmbH (RTR), whose key task is to safeguard the financing and implementation of the facility. The private partner, RTA Rail Tec Arsenal Fahrzeugversuchsanlage GmbH (RTA), leases the CWT for 35 years and is responsible for the international marketing and management of the facility. AIT Austrian Institute of Technology (former Österreichisches Forschungs- und Prüfzentrum Arsenal GmbH) holds a 26 % interest in this operating company, the other shareholders include the most renowned rail vehicle manufacturers in Europe (Bombardier Transportation, Siemens, Alstom, Ansaldo Breda, Firema Trasporti). The participation of industrial enterprises guarantees high capacity utilisation and efficient operation of the facility.

Stages of implementation:

1994 to 1996	Preliminary studies
1996	Basic decision on the development of the project based on the preliminary studies
1997 to 1998	Preparation of a feasibility study and development of suitable financing and organisational models
1998 to 1999	Establishment of RTA Rail Tec Arsenal Fahrzeugversuchsanlage GmbH and Rail Test & Research GmbH Completion of project contract between RTR and RTA on 1 March 1999 Preparation of request for proposals and selection of the supporting project consultant, “Ingenieurgemeinschaft Klima-Wind-Kanal Wien” (IGW) Request for proposals for general contract

2000	Selection of general contractor and awarding of contract
2001	Foundation stone ceremony on 8 March 2001
2002	Completion of facility at the end of December

An international request for proposals for the general contract was issued with the support of the engineering consortium "Ingenieurgemeinschaft Klima-Wind-Kanal Wien" (IGW, consisting of JBG Gauff Ingenieure, Dornier SystemConsult and GRE Gauff Rail Engineering). After proper evaluation of the three proposals submitted, the consortium “Arbeitsgemeinschaft Klima-Wind-Kanal Wien”, consisting of AIOLOS, MCE AG and VA TECH Elin EBG GmbH was commissioned with the construction of the facility.

Technology:

The new CWT consists of two test sections that can be operated in parallel and independently of each other and are equipped with separate data collection systems. This allows power cars, single or several carriages or whole train sets to be tested simultaneously and efficiently. The CWT offers optimised testing under extreme climatic and aerodynamic conditions. The climatic conditions can be modified in a wide range: features include adjustable air speeds, continuously adjustable solar radiation panels providing a solar load of up to 1000 W/m², freely adjustable humidity values as well as a rain and snow spraying rig. Climatic cycling tests complete the range of environmental conditions that can be simulated. Power units are available for the production of auxiliary and test voltages used in the various railway networks (static converters in IGBT technology).

The design of the basic elements of the two CWTs is the same. Both are of the Göttinger type: a blower circulates the air in a closed loop. The air passes through a heat exchanger, where it can be cooled down to –45°C or heated up to +60°C. The 6.2 MW cooling unit (at -10°C evaporating temperature) allows rapid cooling of both test sections using three compressors that can be activated separately. The temperature can be reduced, for example, from + 40°C to –30°C at an average rate of 10 Kelvin per hour, thus ensuring that the required temperature can be reached in the shortest possible time.

The two wind tunnels, however, differ considerably in the lengths of their test sections. The large CWT is 100 m, long enough to accommodate a train consisting of a power car and two carriages. The highest air speed is close to 300 km/h. The dynamometer featuring one driven (power rating max. 850 kW) and one non-driven axle, allows braking and traction tests to be carried out.
At 33,6 m, the test section of the small CWT is long enough for a carriage, a trailer truck or a bus. The maximum air speed here is 120 km/h; the dynamometer (for road vehicles) has a maximum power rating of 250 kW. The airflow to the front of the test object can be shut off completely by means of flaps installed at the head of the test section, in order to simulate, for example, a stop and go cycle with doors opening.
A soak room is directly attached to the smaller CWT. This can be used for temperature conditioning of vehicles (adaptation of material temperatures) but also for climatic cycling tests (e.g. thermal simulation of train passage through a tunnel in winter).

Each tunnel is provided with a contraction nozzle with a cross-sectional area of 16.1 m^2 downstream of the heat exchanger in order to guarantee optimal airflow around the test object. The nozzle outlet thus measures little more than half the cross-sectional area of the test section, which is 30 m² (5 m wide x 6 m high). Assuming the frontal area of a rail vehicle to be 10 m², the airflow velocity at the front of a rail car, for example, is the same as that in the gap between the vehicle and the climatic wind tunnel.

Solar radiation is simulated by solar panels, the lateral simulator in the large CWT being 47.5 m long and the one in the small CWT measuring 30 m. The panels are arranged to cover the roof and one side of the test object to ensure homogenous radiation input. An additional solar radiation panel is provided for the frontal parts of the test vehicles (in the flow area of the respective test section), which does not disturb flow characteristics and can be adapted to vehicle geometries.

A snow rig can be inserted into the tunnel so that the entire frontal part of the vehicle can be uniformly covered with snow and ice. Connections for snow and rain nozzles are arranged on both sides of the

tunnel for local snow application. The system can be used at air speeds of up to 160 km/h and temperatures down to –20 °C.
An additional rain rig, which is installed in the ceiling, can be set to a precipitation rate of up to 80 l/(hm²) over the entire test section (both tunnels). The rig sections in the tunnels are divided into segments of 15 m each, which can be activated or shut off separately.

Two outlets located each in the ceiling and wall in the front third of the test section are designed to discharge exhaust gases from combustion engine vehicles. The exhaust air volume discharged through each outlet in the ceiling or wall can be adjusted from 0.32 to 3.2 kg/s at 200°C.

Range of services:

Work in the facility will concentrate on certification tests according to the UIC 553 Code and the corresponding CEN standards for power cars, rail cars and carriages. Major emphasis will be placed on passenger comfort, but also on issues of safety, availability and proper functioning of relevant components and systems. Tramcars, subway trains, busses or new modes of transport, such as magnetic levitation trains or people movers are subjected to similar tests within product development. The tests carried out in the CWT are a prerequisite for high quality in rail vehicle development and research, since they allow vehicles to be tested for their compliance with ever-stricter standardisation requirements.
Tests within tailored test series guarantee the functional safety of mechanical, electrical and electronic components. Thermal comfort, for instance, is safeguarded through the testing of heating, ventilation and air conditioning systems. Functional tests on brakes, doors and windshield wipers show the safety of the components when used under extreme climatic conditions. The tests thus provide accurate information about the system behaviour of these elements, e.g. in connection with the cold start behaviour of power cars.
The service range of the CWT also includes functional tests for trucks, construction machinery or refrigerated trucks under specified environmental conditions. Aircraft wings and power units, chair lifts, high-voltage components, wind power plants or facade elements are also tested for proper functioning under thermal and aerodynamic loads. Athletes, such as downhill skiers, ski jumpers or luge athletes regularly perform wind tunnel tests to improve their performance.

The construction of the new climatic wind tunnel in the Vienna Technology Center efficiently strengthens Austrian expertise in the quality assurance of rail vehicles and gives a decisive impetus to research and development in transport and infrastructure technologies.

Summary:

The new climatic wind tunnel in Vienna is set to continue the tradition of the former vehicle testing station at the Vienna Arsenal. The internationally active, neutral and independent research and testing institute will safeguard the quality of rail vehicles under all weather conditions. Tests under extreme climatic conditions will make a contribution to safeguarding top passenger comfort in series vehicles and to further optimising the safety and availability of rail vehicles. Backed by the long years of experience of its staff – after all, the specialists from the former vehicle testing station will continue their work in the new facility – Rail Tec Arsenal will retain its position as an international centre of excellence for climatic tests. Contract research, self-financed research, studies and services supporting vehicle design will be offered in addition to tests and acceptance tests in the two climatic wind tunnels.

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