Woods
AIR MOVEMENT

TUNNEL & METRO SOLUTIONS

Specialist systems with over 100 years of experience

Safety and performance for all tunnel applications

FläktGroup is a global leader within air technology solutions, and we at Woods Air Movement Ltd. are proud to serve as the North American division of a company who is renowned for delivering products and solutions to thousands of projects all over the world with focus on indoor air & critical air solutions.

Our solutions comprise innovative, well proven and integrated products with the goal to always provide the best comfort, and safety in the most energy efficient way to provide our customers with the optimal life cycle cost, regardless of geographical location.

Leading enterprises and public entities use our solutions to protect and enhance the physical environment for people and valuable property, reputation and customer relationships, providing competitive advantage and financial success.

We enable organizations to be more flexible and agile, increase trust and operate more confidently.

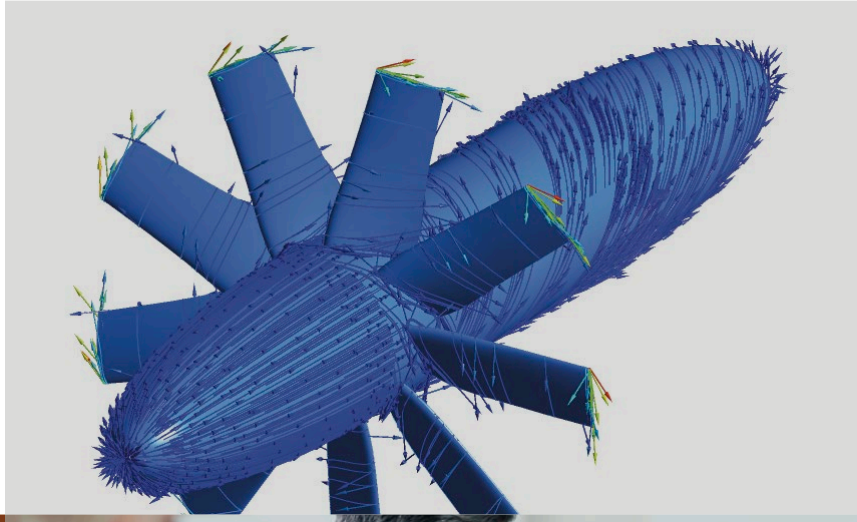
Enabling enterprises to manage their business risks, optimize operations and comply with regulatory obligations is part of our business promise.

We are perfectly positioned to help our clients meet the challenges of operating in the corporate world. Today, we have over 3,600 staff with presence in 65 countries serving clients across Europe, the Americas, Asia Pacific, the Middle East and Africa. We have a strong heritage in protecting assets, applying our technology innovation and track-record of complex solutions integration to solve clients' critical business issues.

Application **Expertise and Support** Services

1 TUNNEL VENTILATION DESIGN & CFD ANALYSIS

The Woods Air Movement Ltd. design team is focused on delivering the optimum design, tailored to local regulations, optimizing air quality, life safety, installed cost and full life cycle costs.



2 PRESSURE DROP CALCULATIONS & VALIDATION OF NOISE CALCULATIONS

Our engineering department is able to assist in making sure all calculations are correct and the products selected meet all requirements.

3

FACTORY ACCEPTANCE TESTING

Our dedicated lab conducts regular FAT's for our clients all over the world. Customers can inspect the factory and understand the manufacturing process so they can have complete confidence in our solution.

4

4. FAN INSTALLATION GUIDANCE & COMMISSIONING ASSISTANCE

Due to the made-to-order nature of tunnel ventilation design, we provide extensive support.

5

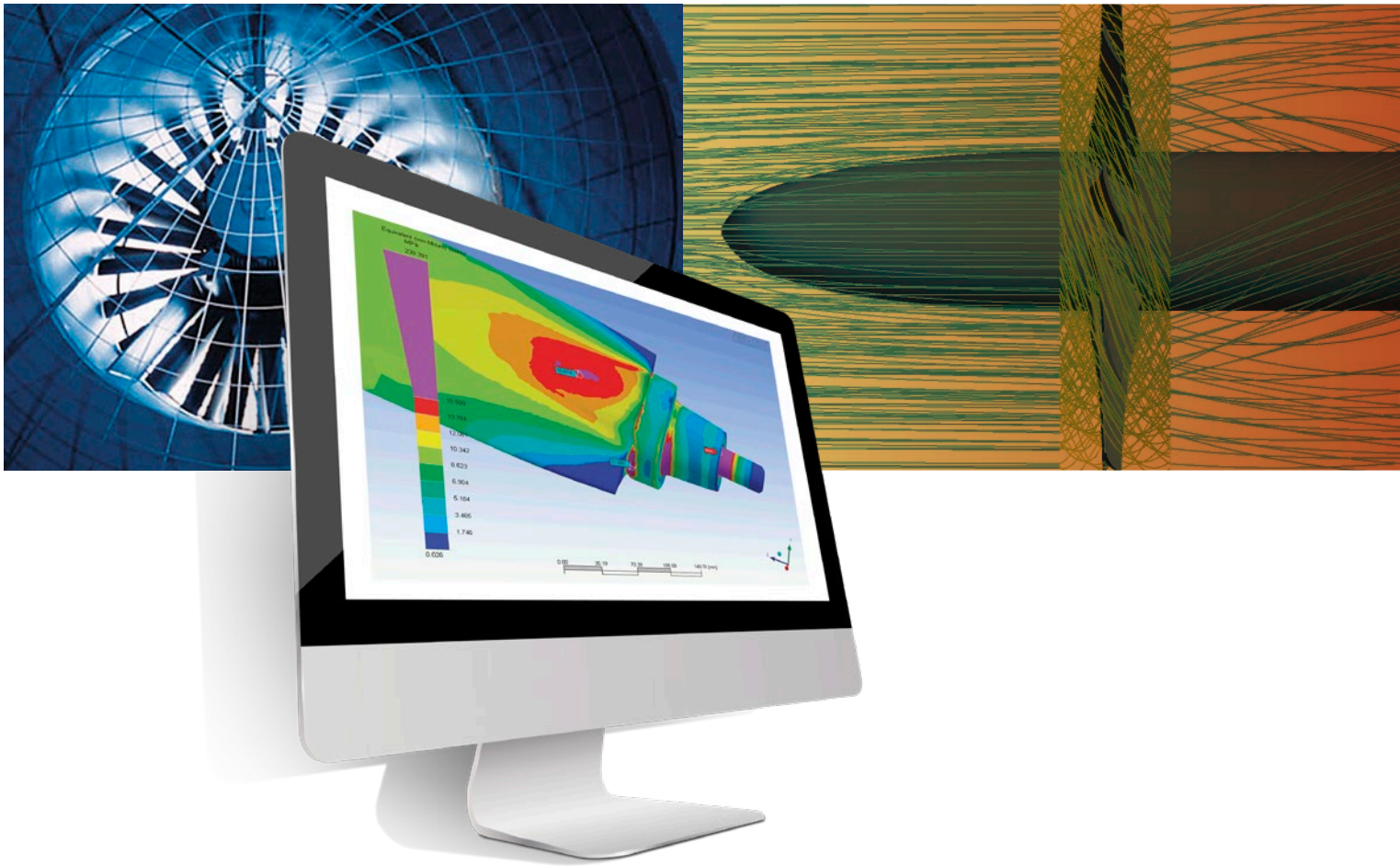
5. GLOBAL COVERAGE & SUPPORT SERVICE

As your local partners, Woods Air Movement Ltd. will work directly with you.

Tunnel ventilation **system design & CFD**

The earlier we are involved in a project, the more value we can add.

By becoming involved at the concept design stage for the ventilation system we are able optimize the fan selections and potentially have a positive effect on other costs within the project. This is particularly relevant for plant room layout and ventilation shaft specification and sizing. In addition to construction costs we also work with designers and contractors to ensure the installation process is simplified as much as possible. This helps us to mitigate risks and reduce installation costs. In order to optimize our solutions we also use advanced CFD modelling to unsure the system as a whole is effective at delivering the required performance.



Verifying our products through simulation and in the lab.

Our Research & Development team uses a variety of advanced simulation tools to optimize product designs for aero performance, efficiency and sound levels. Once a concept is theoretically proven the design can be built and tested in our dedicated laboratory.

TEST STANDARDS AVAILABLE

AERODYNAMIC:

- ISO5801, ISO13350, AMCA210

ACOUSTIC:

- ISO5136, ISO3745, ISO13350, AMCA300
- Dual channel real time frequency analysis, general noise mapping in anechoic environment or with sound intensity, impeller noise traverses

HIGH TEMPERATURE:

- 750°F test system for fans up to 11.5', capable of thermal shock and fan reversal
- Test system operates with a data acquisition system, providing raw and processed data directly on to a PC

VIBRATION AND OVERSPEED:

- We also offer vibration and overspeed testing upon request.

Customer witness testing is available upon request as well as standard end of line testing & documentation.

Road Tunnels

Road tunnels require ventilation to remove pollution and in case of a fire for the control of smoke.

Longitudinal ventilation is used where possible, as it gives the lowest installation and operating cost. The most common method is to use Jetfoil fans where the relatively high velocity discharge induces a flow of air through the tunnel. As the jet from the fan diffuses, it transfers energy to the tunnel airflow and creates an increase in static pressure, which causes air to flow as in any conventional system.

For free flowing traffic in one way tunnels the traffic induced airflow is normally sufficient to ventilate the tunnel even if the tunnel is designed with a fully or semi transverse system.

Large axial flow fans are used for transverse and semi transverse systems where the air is supplied or extracted through ducts from plant rooms. Normally several fans are used in parallel to provide steps in volume flow. Frequently the fans are VFD controlled to provide additional steps in ventilation, a lower operating cost at low levels of flow and low noise levels for night time operation. Often the fans are 100% reversible so that supply fans can also extract. To clear smoke from one side of a fire, reversible fans may be used with the duct system to create a longitudinal flow along the tunnel.

There can also be occasions where a longitudinal system using Jetfoils is justified in addition to a transverse system as the operating cost at low ventilation rates is much less. To avoid pollution at the openings of the tunnel, large fans may be used to capture the tunnel airflow and discharge it at a high level.

Metro & Underground Railways

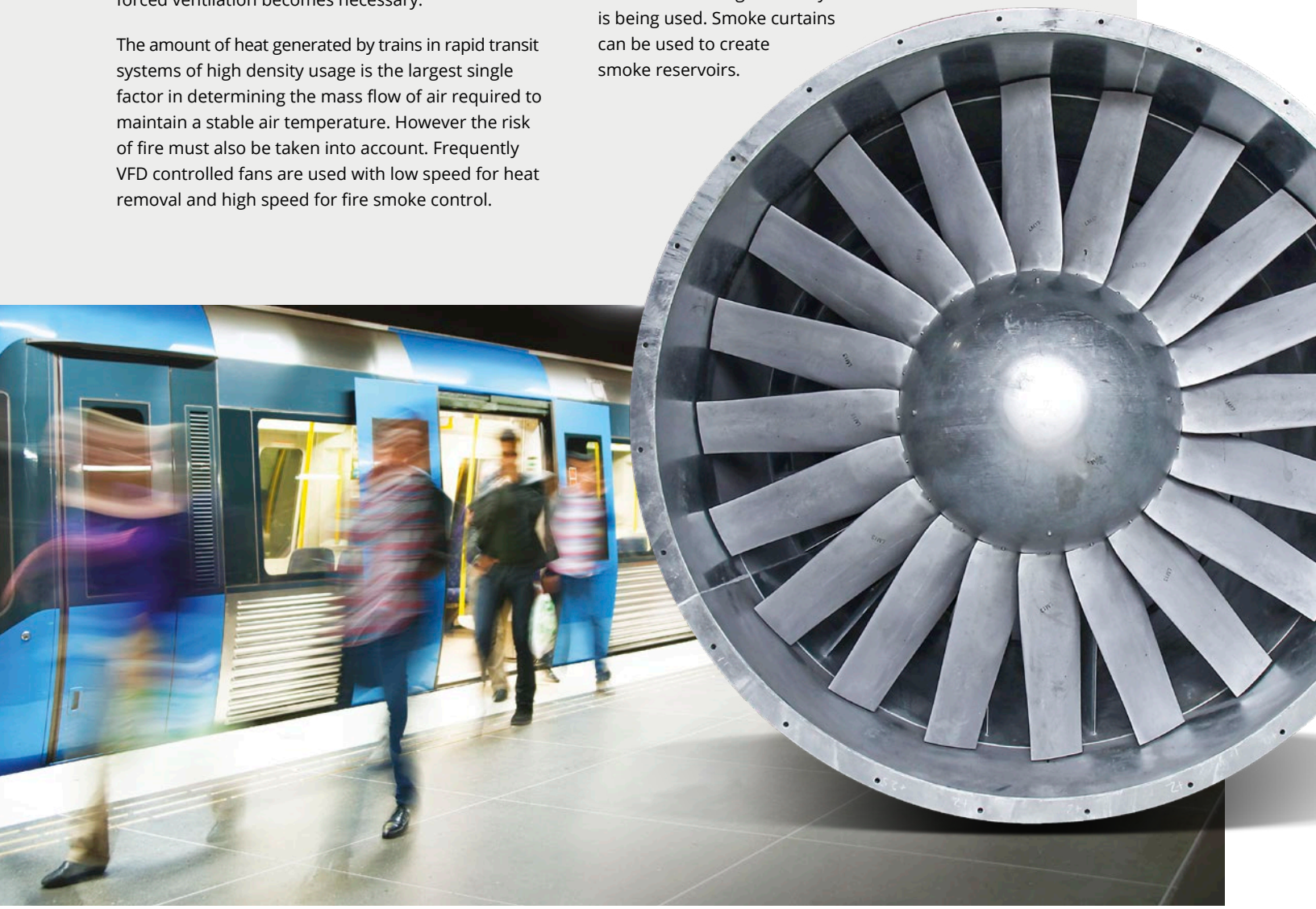
Ventilation is required to remove the heat generated by the trains and other electrical equipment.

Virtually all of the electrical power consumed degenerates into heat which is removed by a combination of natural and powered ventilation. During free running conditions the piston effect of the trains may be sufficient for ventilation and natural ventilation may maintain this condition even when the trains are not operating. However, when the system becomes congested and trains are running at short intervals or, in the case of an incident, are stationary with minimum spacing, forced ventilation becomes necessary.

The amount of heat generated by trains in rapid transit systems of high density usage is the largest single factor in determining the mass flow of air required to maintain a stable air temperature. However the risk of fire must also be taken into account. Frequently VFD controlled fans are used with low speed for heat removal and high speed for fire smoke control.

Longitudinal ventilation along the tunnel is common using 100% reversible fans. For an enclosed system large fans connected to atmosphere would be used in a push-pull configuration. If the system is not enclosed Jetfoils can be used to induce the required airflow along the tunnel to and from atmosphere. Smoke is directed in the most favorable direction depending on the position of a fire in the train or tunnel. Fans are rated up to 750°F for 2 hours.

Air movement in the stations follows normal ventilation practice as far as possible. For smoke control, supply and extract fans are used, reversible if a longitudinal system is being used. Smoke curtains can be used to create smoke reservoirs.



Effective ventilation is an essential requirement for life support underground. Toxic and inflammable gases must be diluted to a safe level; dust and smoke dispersed; excessive heat should be relieved; and escape routes must be kept clear from smoke.

Pollution emitted by trains and road vehicles must be removed to provide an acceptable and safe environment. The heat from a train may need to be removed by forced ventilation to ensure that the temperature is acceptable to both people and equipment. Length of exposure and concentration of carbon monoxide are the important factors in the progressive effects of loss of alertness, headache and unconsciousness. Other products of car exhausts such as nitrogen and sulphur oxides can also have negative health effects of drivers.

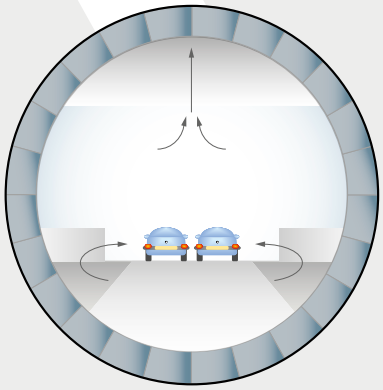
As vehicles become cleaner and more efficient and alternative fuel sources become more common, the day to day ventilation requirement for tunnels will change meaning far more focus is required on the fire safety element of tunnel ventilation for the long term safety of users.

Tunnel ventilation –**smoke & pollution control**

LIFE SAFETY

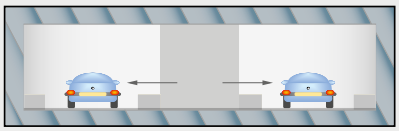
In the event of a fire; large axials and jet fans, or a combination of the two can be used clear smoke from the tunnel to aid in the safe evacuation of the tunnel. The controlling the direction and flow of smoke the ventilation system can also allow firefighters safe access to the fire in order to extinguish it.

There are three main system types used for pollution control and fire safety:



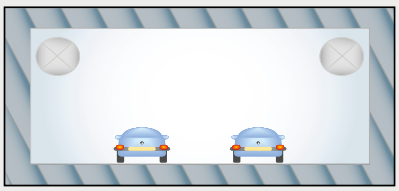
1 FULLY TRANSVERSE SYSTEM

A fully transverse system supplies fresh air from a low level, normally from a duct underneath the roadway. The hot, polluted air rises and is extracted at a high level normally through a ducted system above the roadway.



2 SEMI-TRANSVERSE SYSTEM

This system is similar to the fully transverse system in the supply and extraction of air and is used for long, congested two-way tunnels. Semi-transverse systems rely on longitudinal air movement along the tunnel and require a higher ventilation rate.

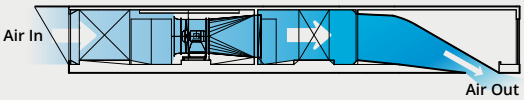


3 LONGITUDINAL VENTILATION SYSTEMS

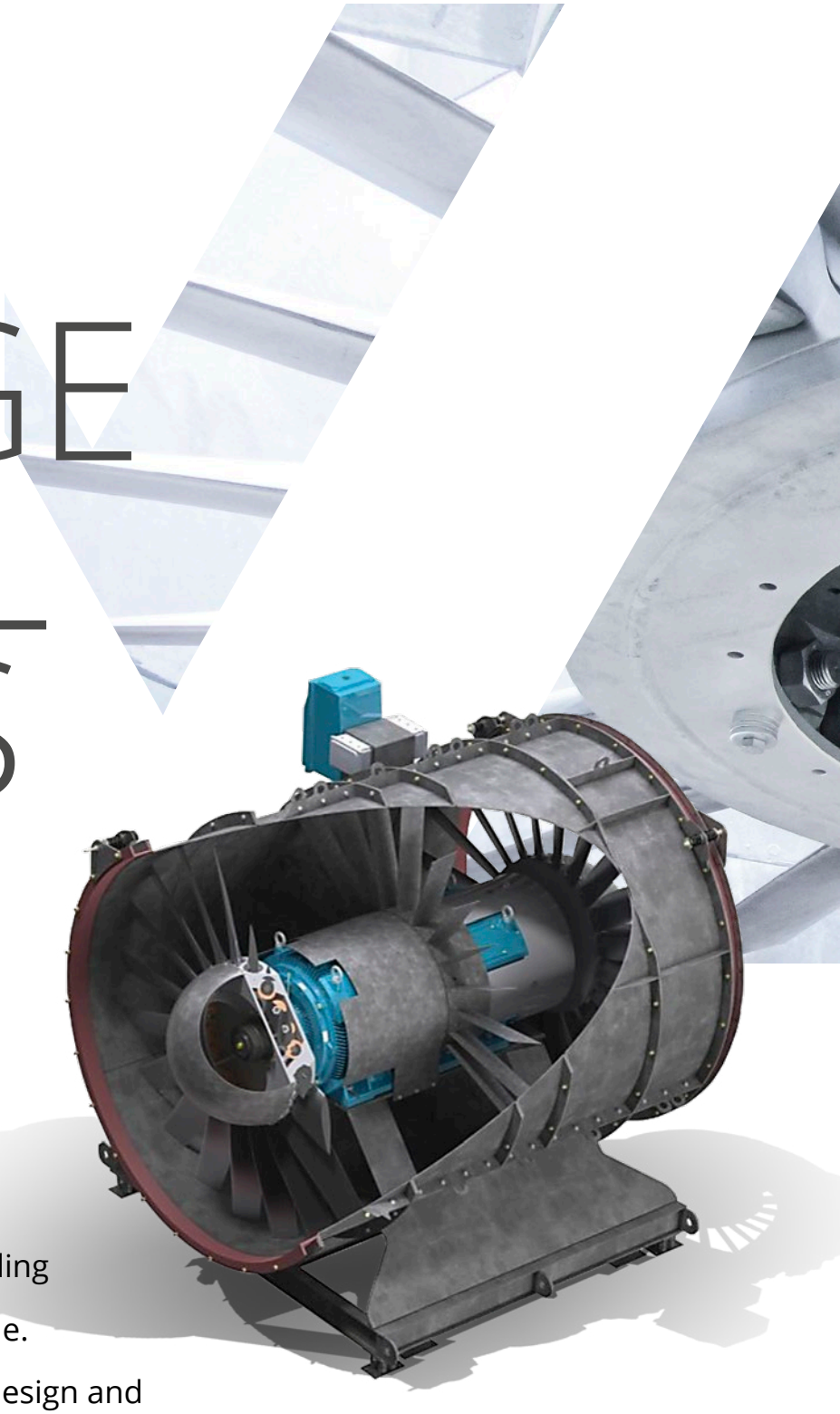
The simplest solution for tunnels as air movement is created along the length of the tunnel by large fans, jet fans or a combination of the two. The air can enter at one portal and leave at another, or be supplied or extracted at points within the tunnel.

SACCARDO NOZZLE

The Saccardo nozzle system operates on the principle that a high-velocity air jet is injected longitudinally into the tunnel to induce a high volume airflow in the tunnel. For this to be successful, the fans have to be carefully matched to optimise performance. The system uses blocks of JM Aerofoil axial fans, multiple units in parallel for each tunnel, and fitted with special nozzles to accelerate the air.



LARGE AXIAL FANS

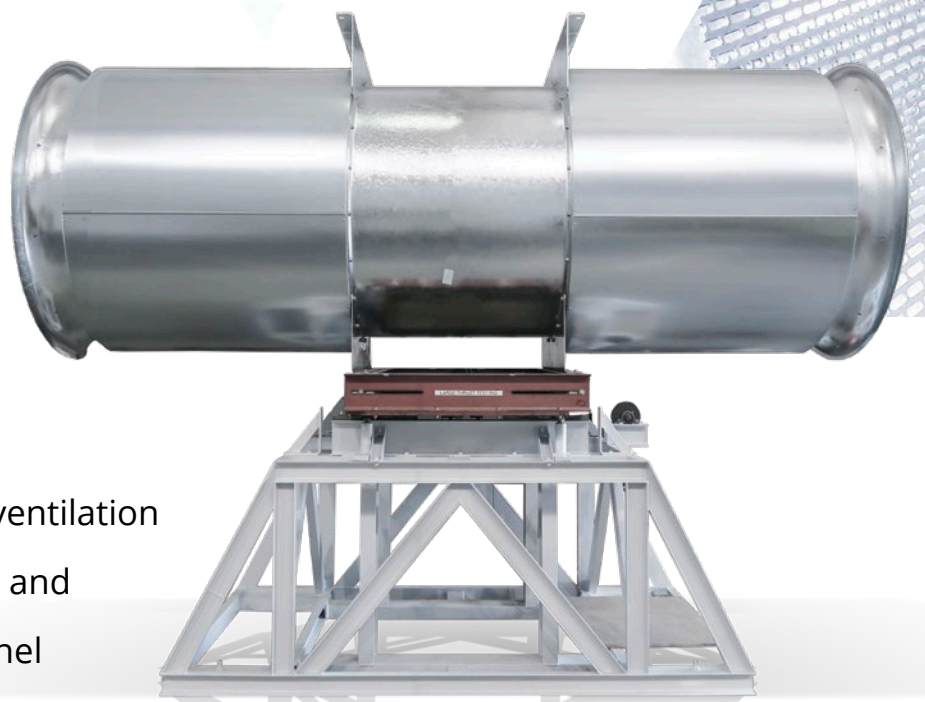


Woods Air Movement Ltd is the industry leader in air movement technology, providing innovative solutions worldwide. Our extensive knowledge of design and applications is based on over 100 years of experience in tunnels, buildings, industry and original equipment manufacturers.

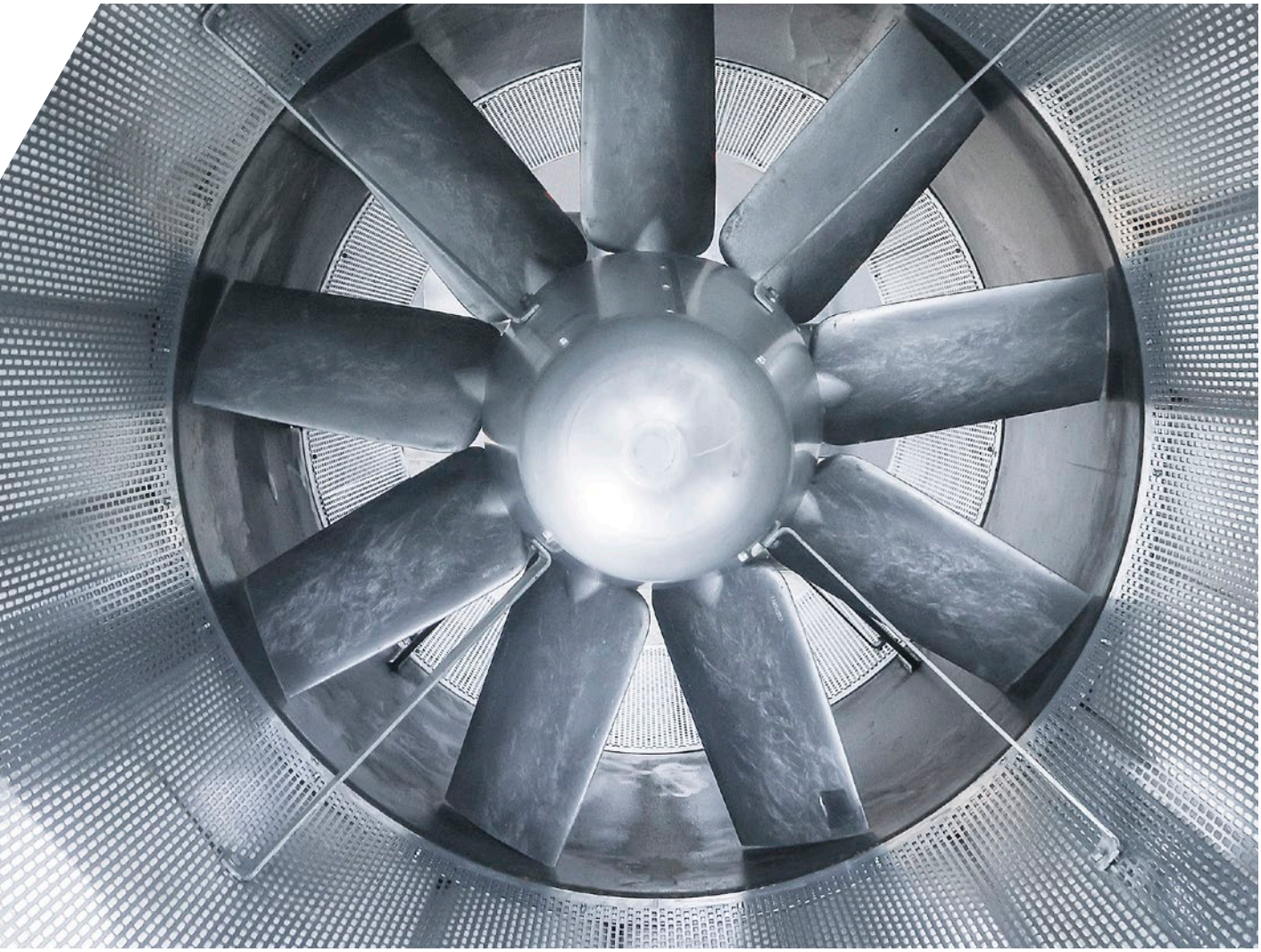
LARGE JM HIGH TEMPERATURE FANS

- Size range 4.1 ft. to 11.6 ft.
- Guaranteed performance to ISO 5801
- Unidirectional or Truly Reversible blade
- Higher pressure twin impeller and 2 stage fans are available
- High Temperature certification for 392°F and 572°F categories up to 710 kW / 950 HP, and 752°F up to 1000 kW / 1340 Hp
- Static pressures up to 0.58 psi and volume flow up to 529,720 CFM
- Fans are tested up to 11.5' diameter, running at 1500 rpm, with a 1000 kW / 1340 Hp motor
- All cast rotating impeller components are examined by X-ray ASTM E155 standards to ensure reliability in service
- IEC motors certified to EN 12101-3 and ISO 21927-3
- Steel parts hot dip galvanized or hot Zinc Sprayed (except hub)
- Manufacturer registered and assessed in accordance with BS EN ISO 9001
- Paint finish optional
- Accessories: guards, condition monitoring, anti vibration mounts, flexible connectors, bellmouth/ coned entries, diffusers, transition pieces, silencers, dampers, starters and controls

JETFOIL FANS



Our expertise in tunnel ventilation applications covers road and rail tunnels, metros, tunnel construction and wind tunnels. Woods Air Movement Ltd. products have been successfully used in underground projects throughout the world and our Jetfoil product range is unrivalled in its technology, innovation, efficiency and thrust.



JETFOIL FANS

- 22” - 63” diameter
- Thrust up to 3500 N / 786.8 pounds
- 31.5” up to 1800 rpm, 9.2” up to 1800 rpm and 63” up to 1200 rpm
- Fully adjustable die cast aluminium impellers in uni-directional and truly reversible configurations; and 100% X-ray of all cast impeller components
- Mild steel casing - hot dipped galvanized after manufacture, painted or all stainless steel construction
- Silencers fitted where required
- Motor protection IP55 minimum
- NEMA motors available in all sizes and temperatures
- IEC motors certified to EN 12101-3
- Emergency ventilation options up to 750°F / 2 hours
- Truly reversible fans provide approximatey equal thrust and airflow in forward and reverse directions
- Noise Levels: acoustic analysis and attenuators to ensure the fans are In accordance with environmental requirements and local regulations is available
- Applications; longitudinal ventilation of road tunnels, mine ventilation, emergency ventilation - smoke control, hangar/large area ventilation

Additional **features**

› DAMPERS

Key to the control and operation of many ventilation systems are control dampers. These should normally be sized on an airway velocity of 1500 fpm or below in order to avoid excessive system pressure and excess sound generation. Physical support must be designed in to accept both static and dynamic loading.

› VIBRATION/CONDITION MONITORING

Principle operating monitoring systems are available on the fans to minimise risks of breakdown and enable programmed maintenance to be effectively planned. Options include bearing vibration and temperature systems, bearing condition monitoring and motor winding condition. We will be pleased to discuss the best choice for your application.

› MOTOR STARTERS/INVERTER DRIVES

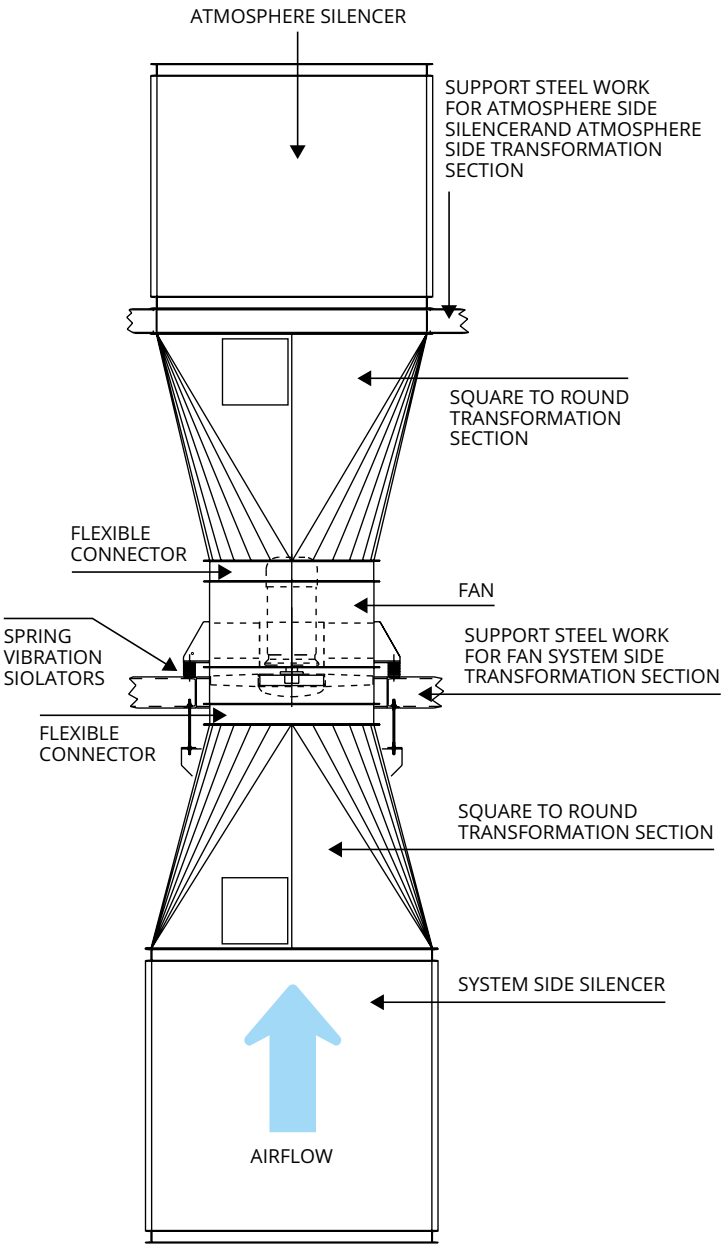
Drive systems can be supplied and specified through Woods to match the operating characteristics of the fan drives and ensure compatibility of the complete package. Interfacing with key control and management systems are principle specification requirements.

› ATTENUATORS

Woods Air Movement has over 50 years experience in sound control engineering and can assess and design attenuators to meet sound attenuation on both system and atmospheric sides. Attenuators can be provided as complete units, modules and splitter only to suit concrete shafts and housings. Airways velocity above 2000 fpm should be avoided to limit system pressure and noise generation.

› AFTER SALES SERVICE

Woods Service and Repair Division offer a full range of site support activity that includes routine monitoring site surveys and service contracts. Please contact us for further details.

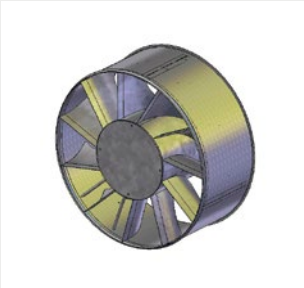


TYPICAL INSTALLATION
VERTICAL AIRFLOW

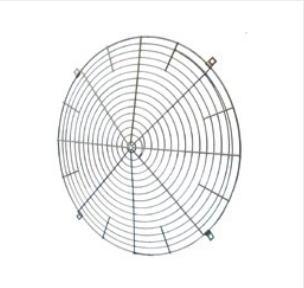
Product accessory examples

Inlet cones

Flexible sleeves and matching flanges

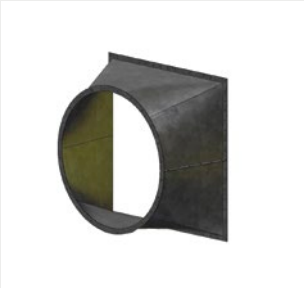


Diffusers

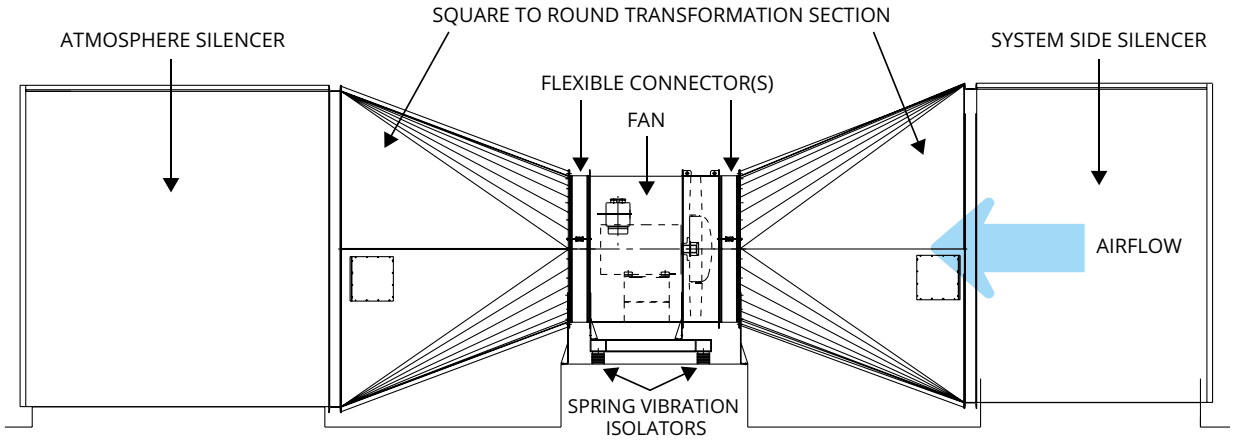


Inlet wire guards

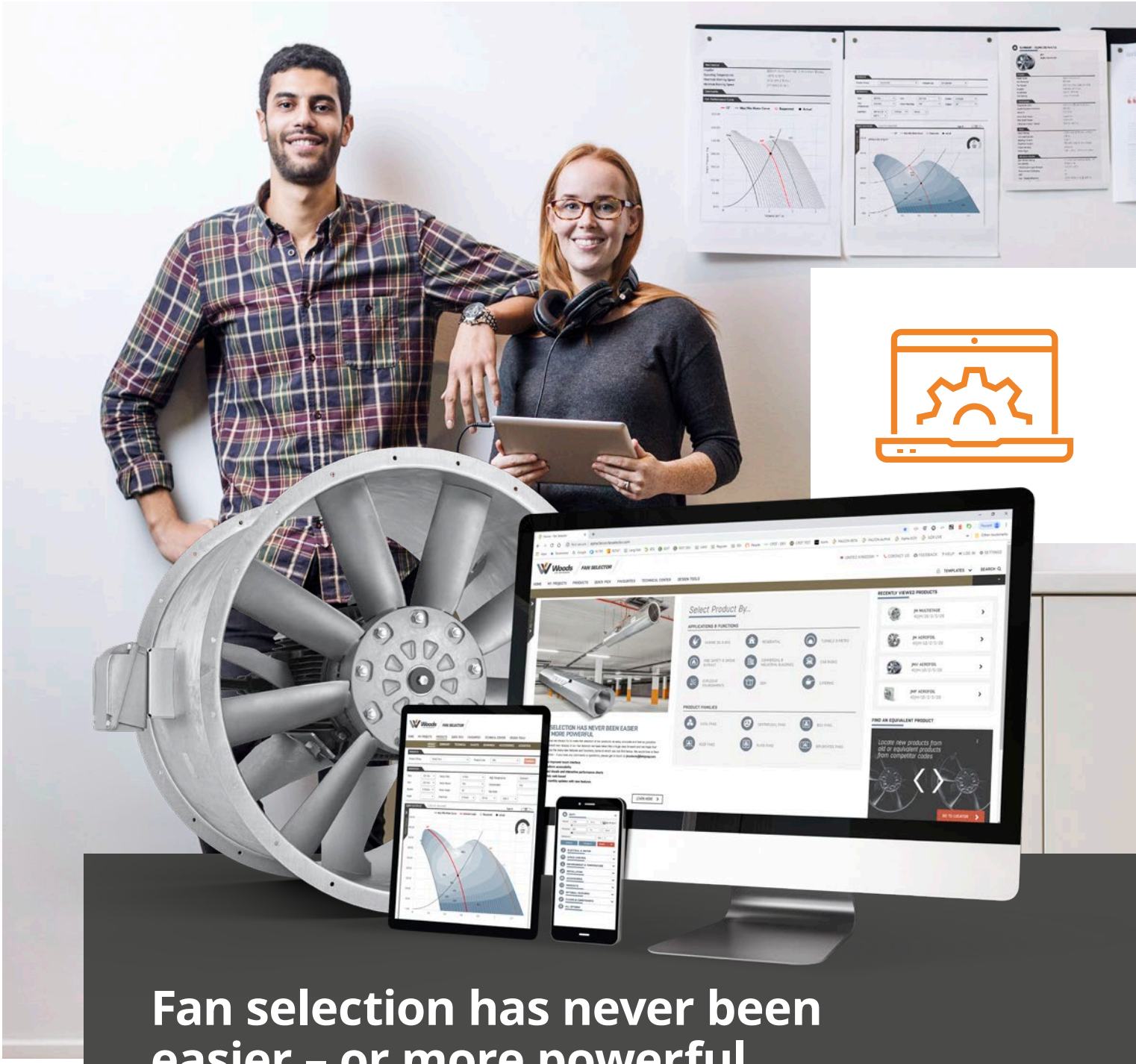
Anti vibration mountings



Transitions pieces



TYPICAL INSTALLATION
HORIZONTAL AIRFLOW



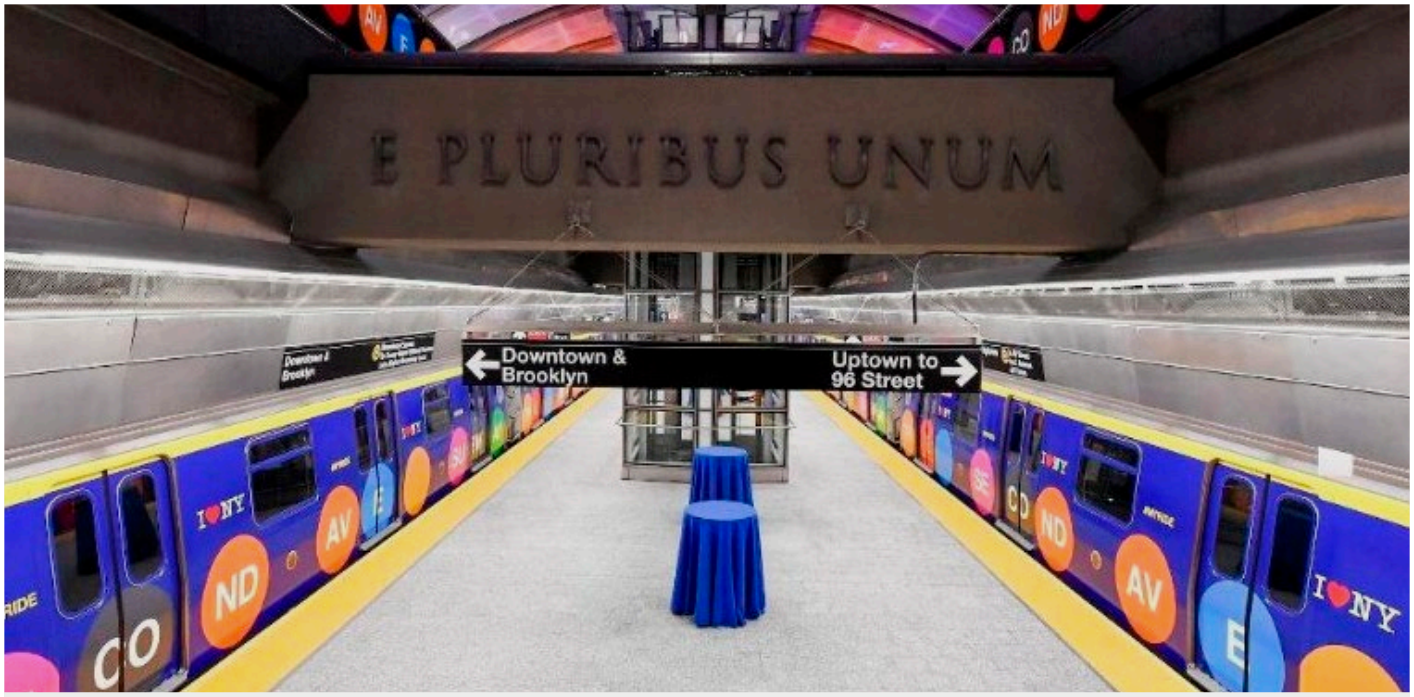
Fan selection has never been easier – or more powerful

At Woods Air Movement we always try to make the selection of our products as easy, accurate and fast as possible. With the new release of our Fan Selector we have taken this a huge step forward – it includes a number of new features and functions to make your job easier.

› **fanselector.woodsairmovement.com**

- New and improved touch interface
- Multi-platform accessibility
- Enhanced visuals and interactive performance charts
- Completely web-based
- Regular monthly updates with new features

Woods is an experienced partner for your safety critical ventilation projects in all environments

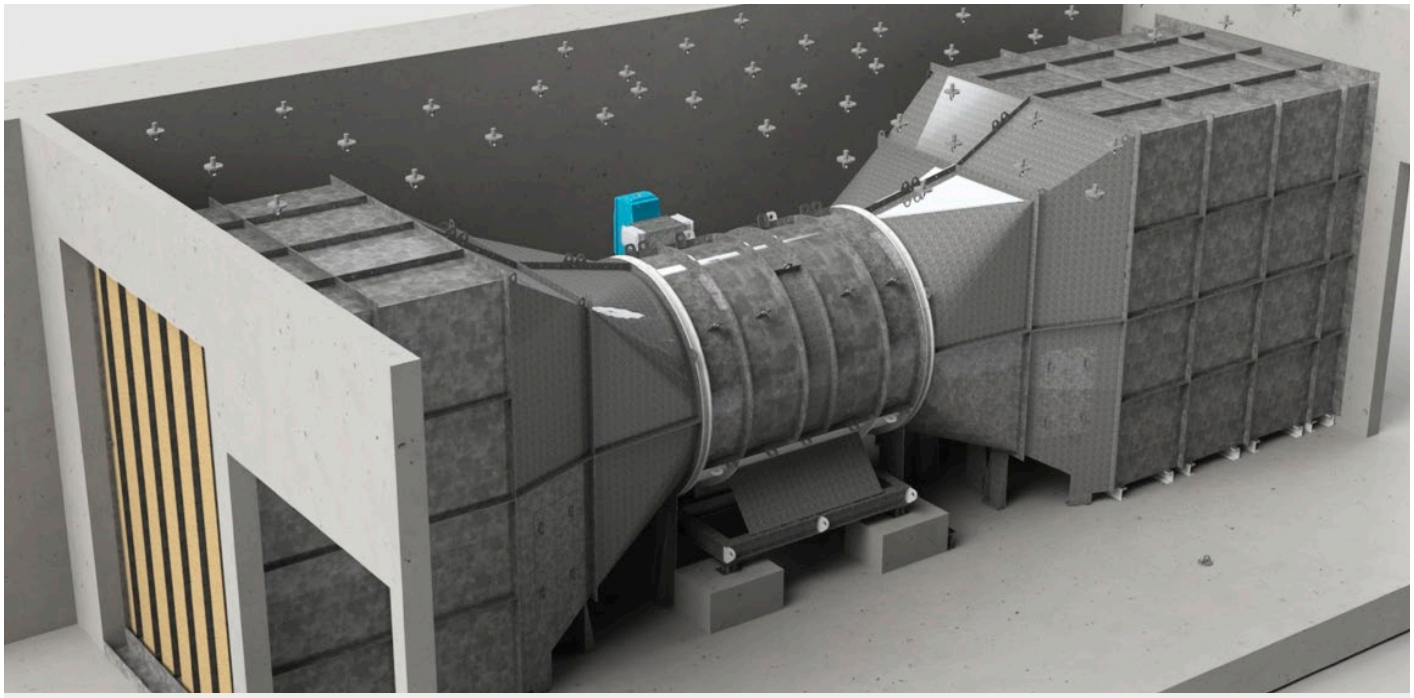


72nd Street Station

New York City Subway

The Metropolitan Transit Authority (MTA) in New York City averaged 5.5 million passengers each weekday in 2017. The 72nd Street Station is among MTA's network of 472 stations - making the New York City subway system the largest in the world. Laid end-to-end, subway system's 665+ mainline track miles would stretch from New York City to Chicago!

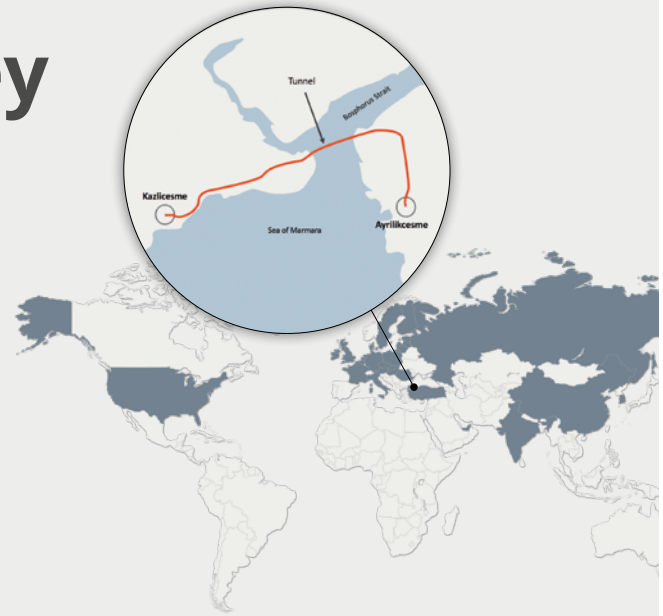
PROJECT	NEED	SOLUTION
New underground station is part of the MTA's Second Avenue Subway Program, the first major expansion of New York City's subway system in more than 50 years.	Major projects included installation of a ventilation system including fan and chiller plants within the station and its ancillary structures	• (8) 250hp JM Aerofoil Class F200 Fans



Marmaray, Turkey

Railway tunnel project

Stretching for over 8.5 miles across Istanbul and under the Bosphorus Strait, the tunnel is the only one in the world connecting two continents and has been designed to develop important trading routes in the region. The rail service will be capable of carrying 75,000 people per hour in either direction. The tunnel ventilation fans consist of 30 double impeller fans with diameters of over 8 feet, as well as 18 single impeller units with diameters of 5.25 feet.



PROJECT	NEED	SOLUTION
The Marmaray project has upgraded existing suburban train lines to create a direct link joining the southern part of the city across the Bosphorus Strait.	Istanbul is one of the world's biggest cities, with over 16 million people. Some two million, according to the AFP news agency, cross the Bosphorus every day via just two bridges, causing severe congestion.	• (30) 8 ft. diameter fans • (18) 5.25 ft. diameter fans • (9) Jet Fans

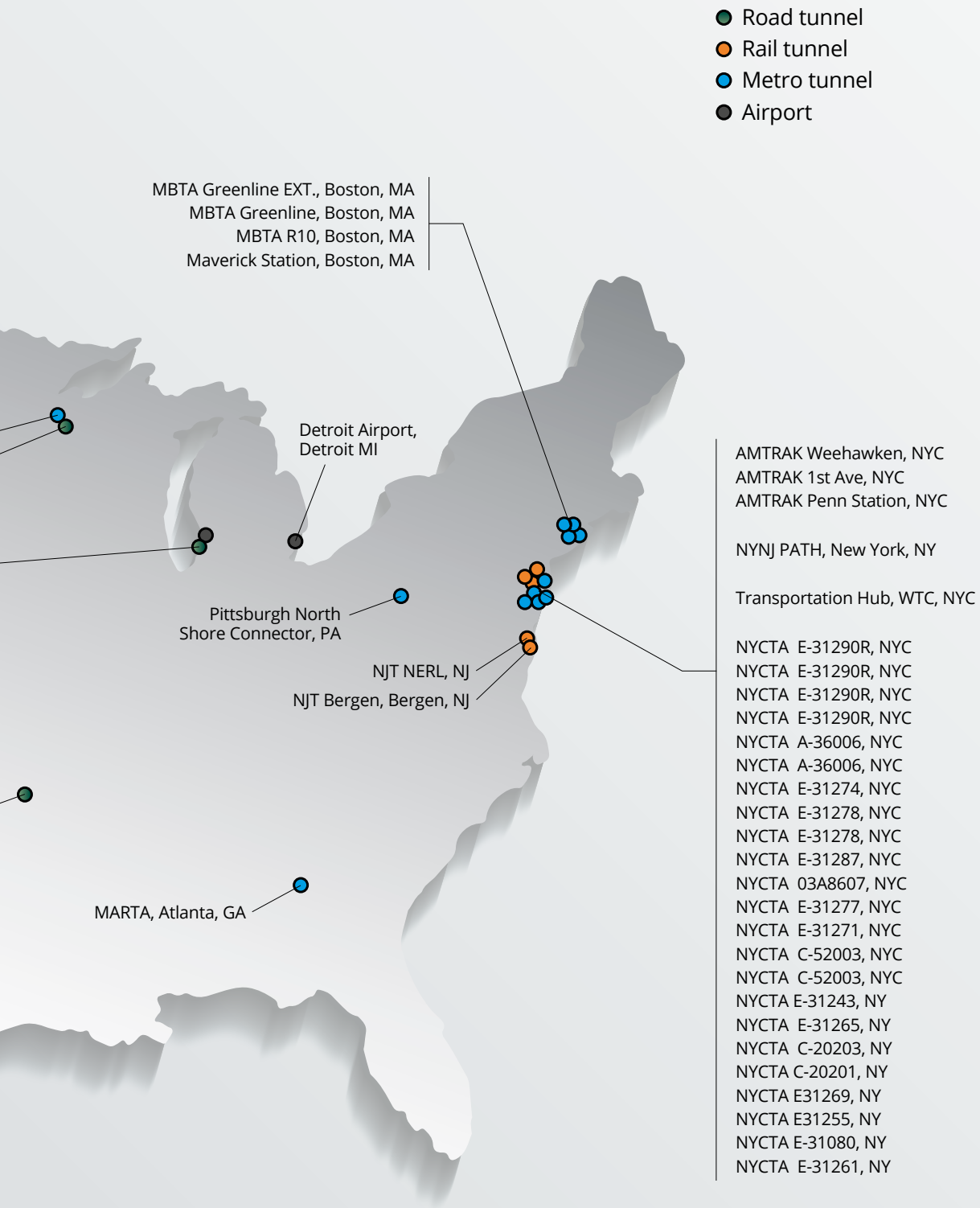
A selection of other
Tunnel & Metro projects

OTHER PROJECTS

- Whittier Tunnel, AK

- Toronto Airport, Toronto Canada
- Palais de Congres, Montreal, Canada
- Toronto Transit Commission/York Mills, Canada
- STCUM, Montreal, Canada

- Tren Urbano, Puerto Rico


Road tunnel
Rail tunnel
Metro tunnel
Airport
MBTA Greenline EXT., Boston, MA
MBTA Greenline, Boston, MA
MBTA R10, Boston, MA
Maverick Station, Boston, MA
Detroit Airport,
Detroit MI
Pittsburgh North
Shore Connector, PA
NJT NERL, NJ
NJT Bergen, Bergen, NJ
MARTA, Atlanta, GA
AMTRAK Weehawken, NYC
AMTRAK 1st Ave, NYC
AMTRAK Penn Station, NYC
NYNJ PATH, New York, NY
Transportation Hub, WTC, NYC
NYCTA E-31290R, NYC
NYCTA E-31290R, NYC
NYCTA E-31290R, NYC
NYCTA E-31290R, NYC
NYCTA A-36006, NYC
NYCTA A-36006, NYC
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NYCTA E-31277, NYC
NYCTA E-31271, NYC
NYCTA C-52003, NYC
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Woods
AIR MOVEMENT

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Woods Air Movement Ltd. delivers smart and energy efficient Air Movement and Fire & Life Safety solutions to support every application area. We offer our customers innovative technologies, high quality and outstanding performance supported by more than fifty years of accumulated industry application experience. The widest Tunnel & Metro product range in the market, and strong market presence with 30 years of experience and manufacturing in the USA, guarantees that we are always by your side, ready to deliver Excellence in Solutions.

To register for Certified Product or Application training please contact us via:

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