

Tunnel ventilation solutions for underground transport systems

High performance air provision where reliability and safety matters



Complete ventilation systems from design to installation delivering industry leading performance you can rely on.

Howden, a Chart Industries Company, has been at the leading edge of industrial fan and air moving equipment design for more than 160 years. Operating from bases in 26 countries spread across every continent, we offer a truly global service.

Ventilation systems are critical to providing a safe environment for both travellers and transport workers.

To ensure this, Howden's expertise starts at concept and continues throughout the lifetime of operation using leading modeling, fan and digital technology to deliver a truly end to end solution.



Simulate: Software

Ventsim™ software to design optimal systems for flow and performance. Fan engineering based on expert analysis of project duties.



Ventilate: Hardware

High performance fans providing reliable continuous and emergency air and smoke extraction.



Optimize: Digital

Automate fan control through Ventsim to optimize operation. Maximize performance levels with Howden Uptime digital technology coupled with specialist aftermarket support.

Why Howden?

Howden has extensive application knowledge accumulated from nearly 100 years of developing and supplying ventilation fans for tunnels. This expertise is applied to each project and fan selection to ensure that performance meets or exceeds our customers' requirements.

Our offer starts in the design stage enabling ventilation demand models to be developed and understood. Once this progresses to fan selection, Howden provides fully costed proposals including predicted operating costs as well as capital expenditure and full technical specifications.

Our wide duty coverage, using both axial and jet fans, allows the optimal arrangement for tunnels of all sizes and situations. Quality and the resulting reliability is critical in tunnel operations and this is a key attribute at Howden.

Our manufacturing facilities maintain the highest levels of excellence with modern equipment and strict quality controls accredited to international

standards. A full test capability across our entire range ensures confidence in the performance quality of each unit.

With over 50 manufacturing and service sites globally we have the largest coverage for sales and aftermarket support. This means we can respond swiftly to our customers' needs in the project stages as well as through the operational lifetime of equipment. Our service organization provides full support worldwide to keep your system working continually, on demand, as expected.





Our ventilation equipment complies with the most stringent specifications in the world.



Designed and built to the highest standards ensuring safety and reliability long-term



Flexible fan range to optimally meet conditions of each tunnel



High efficiency fans delivering best performance **at lowest operational cost**



Fully scoped systems **using design and simulation models**



Complete system solution and delivery reducing project complexity and costs



Optimized operation via digital control and monitoring technology

Solution coverage

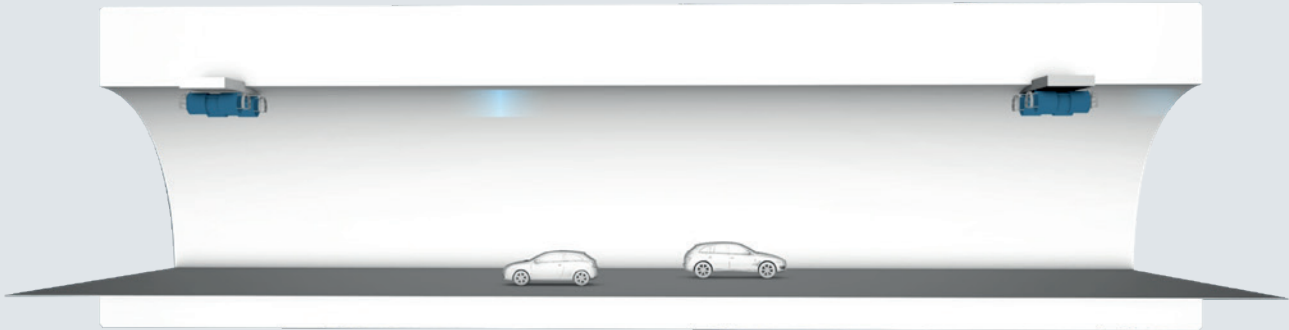
Howden's solutions are focused on the need for ventilation in underground transport infrastructure.

Increasingly these modes of transport are being developed within underground settings requiring tunnels and/or stations that are suitably ventilated for safe operation.

Within these operations the ventilation system can be based on two fundamental configurations - longitudinal and transverse.

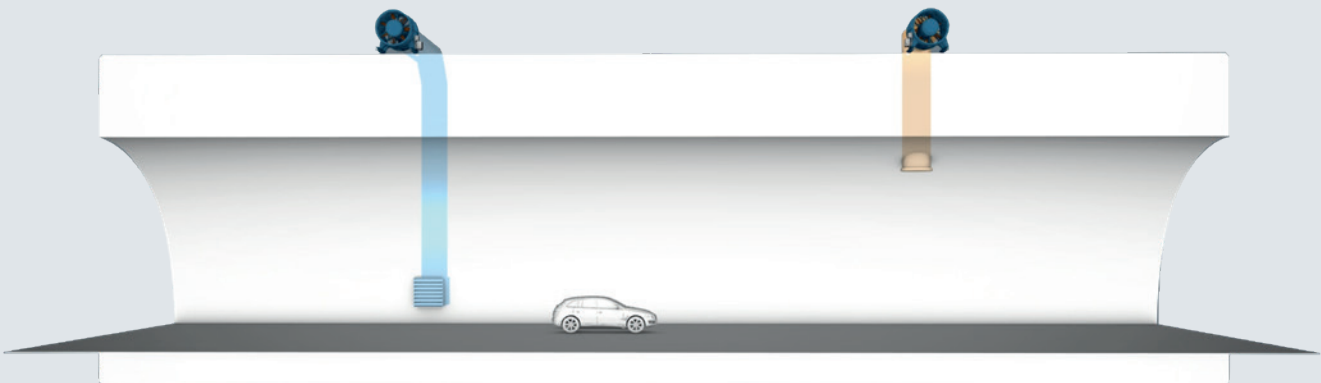
Longitudinal

- Ventilation air enters the end of the tunnel, and is driven through by impulse transmission supplied by jet fans
- Longitudinal systems are generally the most economic system, because there is no need for external ventilation buildings or infrastructure, and running costs are relatively low



Transverse

- Ventilation air is delivered into the tunnel at intervals throughout its length by large axial fans
- Transverse systems are generally more expensive to construct and maintain due to increased infrastructure, including one or more ventilation stations above ground and ducting to distribute the air



High efficiency fans optimized for each tunnel project

With a wide range of ventilation fans covering longitudinal and transverse configurations Howden can meet the specific requirements of each project.

Different blade designs offer flexible solutions when considering traffic volumes and air flow requirements. This ensures the optimal fan selection for the conditions expected in each specific tunnel.

Both axial and jet fans offer highly efficient performance to minimize operational costs.

Howden axial fans are capable of up to 90% efficiency in forward flow and 80% in reverse flow. For our jet fans, efficiency is enhanced by the high thrust delivered relative to the power consumption.



High efficiency



Flexible configuration



Low lifetime costs



Fans meeting the highest standards in safety and performance

Howden, a Chart Industries Company, can provide a full solution for tunnel ventilation based on our product, software and service capability.

Every fan is designed and manufactured to the highest quality standards to deliver long term performance and an immediate response when needed most during emergencies.

Giving assurance of safe and reliable operation within the event of fires, the fans are tested to the most stringent fire safety standards (EN 12101-3, NFPA 130/502 or ISO 27927).

This ensures the fans meet regulations for the required length of continued operation from 302°F/1h up to 752°F/2h.

Aerodynamic testing of fans ensures that performance meets or exceeds all required standards demanded by project specifications. Noise operational limits in accordance with regulations are also met by additional silencers – packaged with axial fans and integrated with jet fans.



Safe and reliable



Assured performance



Compliant solutions



Howden's range of axial and jet fans

Our fan range enables us to meet all flow requirements with multiple options such as blades and motors designed to offer the right fan for each duty.



Axial



Jet

	UMAF	UMAF/Variax	AP/AQ
Blades	Adjustable (at standstill)	Adjustable (in operation)	Adjustable (at standstill)
Configuration	Uni-directional or fully reversible	Uni-directional or fully reversible	Uni-directional or fully reversible
Flow range	Flow from 40,000 CFM to 850,000 CFM	Flow from 40,000 CFM to 850,000 CFM	Flow up to 120,000 CFM
Flow control	<p>Blade pitch set during manufacture according to the duty required for each project. This can be adjusted if required during standstill.</p> <p>Flow control can be provided by using a variable speed drive.</p> <p>Ivanov anti-stall device as an option.</p>	<p>Variable pitch which can be adjusted to optimize the volume flow to a wide range of operating conditions.</p> <p>This allows maximum control and operating efficiency.</p> <p>Ivanov anti-stall device as an option.</p>	Flow control can be provided by using a variable speed drive.
Pressure (Axial)/ Thrust (Jet)	0.8" wg to 16" wg	1.2" wg to 120" wg <i>Two stages if required for higher pressures</i>	57lb to 755lb
Motor power	150 hp to 1000 hp	500 hp to 20,000 hp	30 hp to 125 hp
Outer diameter	From 49.6" up to 124.4"	From 49.6" up to 248"	From 5.7" up to 63"

Complete ventilation from design to operation

Howden can provide a full solution for tunnel ventilation based on our product, software and service capability.

At the design stage, Ventsim enables the ventilation system to be modeled in 3D providing an understanding of potential options.

Performance can be simulated based on expected operating conditions and evaluated to allow the selection of an optimized design.

When it comes to fan selection, Howden's specialized project engineering expertise means that we are able to interpret design requirements, provide options and

offer the best matched fans for each project. Fans are enabled with Howden Uptime giving operators the benefit of real time monitoring against ideal performance metrics and intelligence to control fan operation and minimize costs.

Project delivery can be provided on a scalable basis with full turnkey provision available to reduce project complexity, cost and management during design and installation stages.



Operational support

Full lifetime service coverage can be aligned to the fans and system taking advantage of the Howden global aftermarket network.

With a permanent presence across every continent and specialist engineers, we are able to ensure reliable performance long term through expert maintenance and quick resolutions to any unexpected issues.



Optimized system design



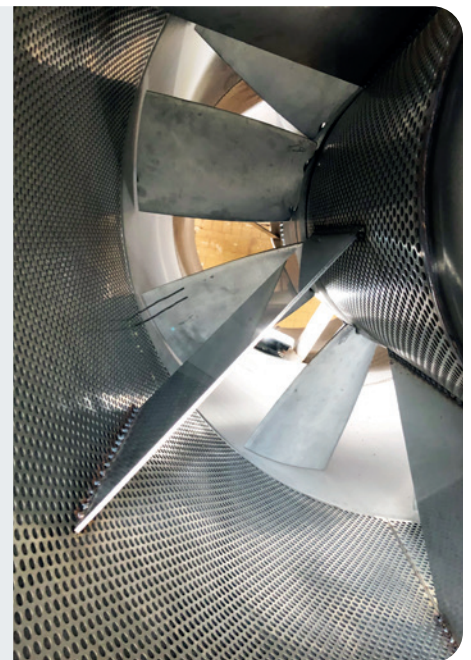
Turnkey delivery




Specialized project support



Reliable lifetime operation





Ventsim is a dynamic and powerful tool that can be used within the design and construction phase of tunneling projects to understand the impact of decisions.

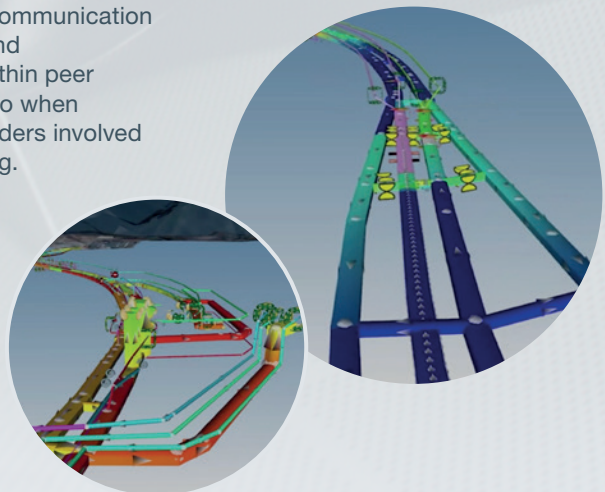
Ventilation design with Ventsim

Ventsim is an underground ventilation simulation software package designed to model and simulate ventilation, airflows, pressures, heat, gases, fire and many other types of ventilation data from a model of tunnels.

Working with the data relative to expected traffic flows, aerodynamics and piston effect, multiple scenarios can be evaluated to provide the optimal design.

This enables designers and potential operators to ensure requirements are fully met and assists the system selection process.

The tool enables easier communication of the different options and considerations for use within peer groups for review and also when presenting to all stakeholders involved in project decision making.

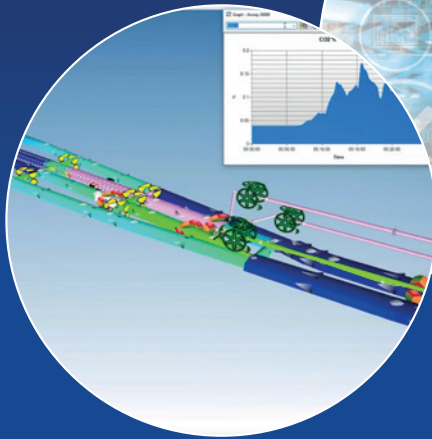


Ventilation optimization

Ventsim Control

Our powerful ventilation on demand software, enables ventilation to be optimized based on current conditions.

Using information such as traffic conditions, gas level or temperature, the airflow requirement can be calculated and achieved through the control of fans and louvers.



Howden Uptime

Howden Uptime provides a unique and innovative platform for gathering, interpreting and analyzing fan data on a real time basis.



Our Howden Uptime service includes:

- Vibration (on motor bearing)
- Static (air) pressure
- Flow
- Pitch angle
- Temperature (motor winding, bearing)
- Voltage
- Current (3 phases)
- Operating speed

The constant recording of these parameters provides insight into the overall health status of the fans and prompts operational adjustments where beneficial **to maximize performance.**

Aftermarket support

Digital technology combines to optimize fan operation through automated controls and maximize performance.

With access to specialist engineers, we can bring quick resolutions to unexpected issues minimizing downtime and ensuring reliable long-term performance through expert operations and maintenance services.

The range of services on offer support our ventilation equipment as well as fans supplied by other manufacturers.

Our range of services includes:

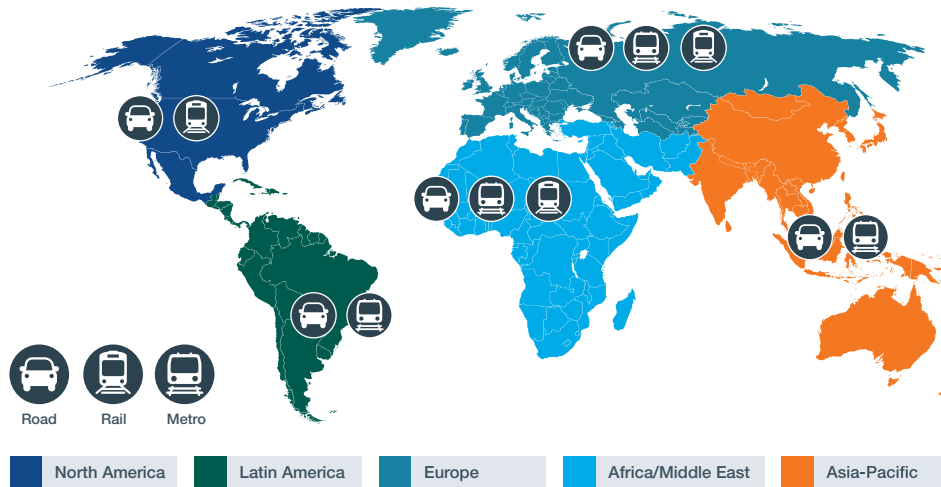
- Inspections
- Repairs and refurbishments
- Retrofits and performance enhancements
- Balancing
- Testing and training
- Spare parts and inventory management

Services are delivered either on-site or in our workshops depending on the nature of the service and customer requirement.



Howden experience

Howden has been designing and manufacturing ventilation fans for tunnel applications since the 1920's.



These have been delivered under a range of legacy and current product brands such as Variax, Voith/Howden Ventilatoren Heidenheim, Axicent, Axico, Joy, Buffalo Forge, American Fan, Stork and UMAF.

To date over 6,200 fans have been installed in a wide range of road, rail and metro projects globally.



E-130 Project Overview, Sound Transit

The project entailed the delivery of 27 Jet fans that were split (12 and 15) between tunnels connecting Mercer Island and Mt. Baker in a tunnel travelling to the west of Seattle through Mercer Island to Beaux Arts Village. Howden's ability to fully comply with Buy America and its status as the preferred supplier for Sound Transit made it the obvious choice for this project. Ultimately, it was on time delivery coupled with smooth project management that provided a winning solution. The key to the success of this project was Howden's engineering expertise, production at local facility and key sourcing of some components. Howden chose the JM design for this project.



World Trade Center Station, MTA

For this project, Howden delivered 2 vent fans to sit right at the World Trade Center station. As a preferred vendor of MTA, we worked closely with their team to design the best possible solution. Howden was able to meet all challenges, including the location of the fan in an open room gateway. A key aspect of this project was the fact that the fan assembly room was an open room gateway that was required to be heatproof. Normally, a guideway would allow heat to go directly into the inlet of the fan and up the outlet to be dispersed. Our JM design was used for this project while our engineers did all selection and modelling and production met all Buy American requirements.



C-70 Tunnel, Denver

The C-70 project in Denver, Colorado turned an Interstate 70 overpass into a tunnel to allow for reduced congestion. Howden delivered (18) jet fans for the project to allow for proper tunnel ventilation according to NFPA 502. For this project we used the APR 1250/578 jet fan model, which is a design out of our axial fan business in Denmark. Howden worked with design engineers to accommodate the sound requirements, which were very stringent due to the proximity of the tunnel to nearby neighborhoods. The design engineers were very pleased with the exceptionally low noise emitted from our fans, a noise level that was significantly lower than the competition, so our fans were specified into the project.

Howden, a Chart Industries Company

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