Howden
A Chart Industries Company

Tunnel ventilation solutions for underground transport systems

High performance air provision where reliability and safety matters

Revolving Around You™

chartindustries.com/howden

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 modelling, 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.

Optimise: Digital

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

Why Howden?

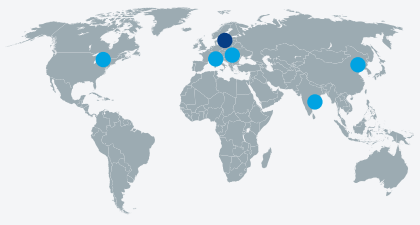
Howden has extensive application knowledge accumulated from over 100 years of developing and supplying ventilation fans for tunnels. This expertise is applied to each project and fan selection to ensure that performance meets or exceeds our customers' requirements.

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 organisation provides full support worldwide to keep your system working continually, on demand, as expected.



● Design centre
● Manufacturing centres

European design centre and regional manufacturing

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

Optimised operation via digital control and monitoring technology

Solution coverage

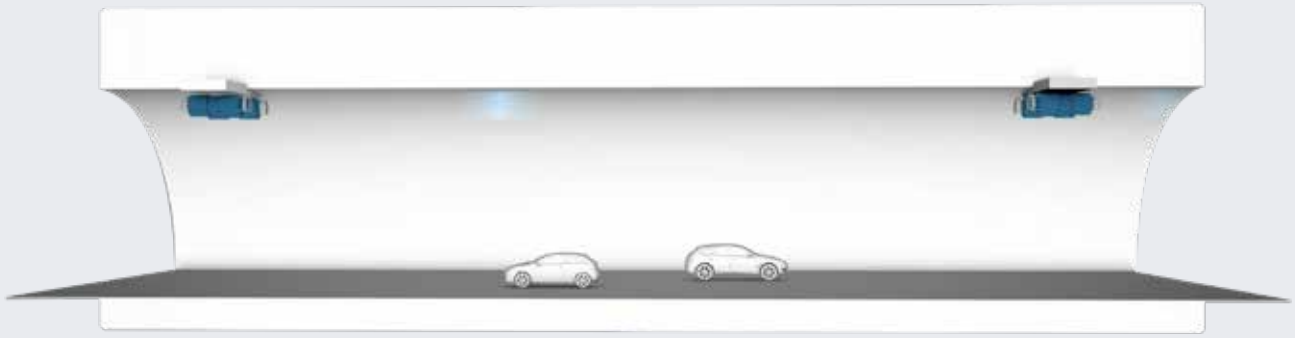
Howden's solutions are focused on the need for ventilation in underground transport infrastructure

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 performance fans optimised for each tunnel project

Whether your project is driven by economics or is striving to reach for the highest efficiency in tunnel ventilation, Howden has a fan to suit

Our axial fan range offers flexible solutions to address expected traffic volumes and air flow requirements with different blade designs, mounting options, materials and configurations. This ensures the optimal fan selection for the conditions expected in each tunnel.

All our fans are designed and selected to provide the best level of efficiency relative to performance to minimise operational costs.

Our core axial fan designs meet efficiencies of 70-74% depending on flow direction, while our premier 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**

Howden's range of axial and jet fans

From highly standardised to tailor-made – fans to meet your project demands

	Axial			
				
	Core	Core Plus	Premier - UMAF	Premier - Variax
Fan impeller	560-1250mm	1250-2500mm	Up to 3160mm	Up to 6300mm
Flow range	up to 60 m³/s	up to 160 m³/s	Up to 400 m³/s	Up to 1600 m³/s
	Meet greater air flow requirements with larger fan impellers			
Pressure	Up to 1000Pa	Up to 1800Pa	Up to 4000Pa	Up to 15000Pa
	Overcome higher pressures associated with longer tunnels/air ducts and greater noise attenuation			
Efficiency	up to 74% or 70% (reverse)	up to 75% or 70% (reverse)	up to 90% or 80% (reverse)	up to 74% or 70% (reverse)
	Achieve best in class operational costs with lower consumption relative to output			
Mounting	Pad	Foot	Flange	Flange
	Achieve better aerodynamic performance and efficiency or configure for vertical flow			
Hub/blade	Plate steel/ Aluminium	Cast Aluminium/ Aluminium	Steel/ Aluminium (option: steel inserts)	Steel/ Aluminium (option: steel inserts)
Fire rating	F300-2h	F300-2h	F400-2h or F250-2h	F400-2h or F250-2h
	Maximise safety with higher resistance to fire			
Flow control	Blade pitch set during manufacture according to the duty required for each project. This can be adjusted if required during standstill. Flow control can be provided by using a variable speed drive.			Variable pitch adjustable in operation. Optimise flow across a wide operating range

All fans can be supplied to operate with unidirectional or reversible flows

Jet

	AP/Q
Fan impeller	Up to 1600mm
Flow range	up to 50 m^3/s Covering a large flow range
Thrust	Up to 3360N Maximising flow per fan
Mounting	Flange or Pad According to required aerodynamic performance
Hub/blade	Pressed steel/ Cast aluminium
Fire rating	F400-2h or F250-2h According to required safety standards
Flow control	Flow control can be provided by using a variable speed drive. Optimising operation to required duties

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 optimised design.

When it comes to fan selection, Howden's specialised 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 minimise 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.

- **Optimised system design**
- **Turnkey delivery**
- **Specialised project support**
- **Reliable lifetime operation**

Fans meeting the highest standards in safety and performance

Reliable continuous and emergency operation is critical for ventilation systems

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 200°C/1h up to 400°C/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**

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

Ventilation design with Ventsim Tunnel DESIGN

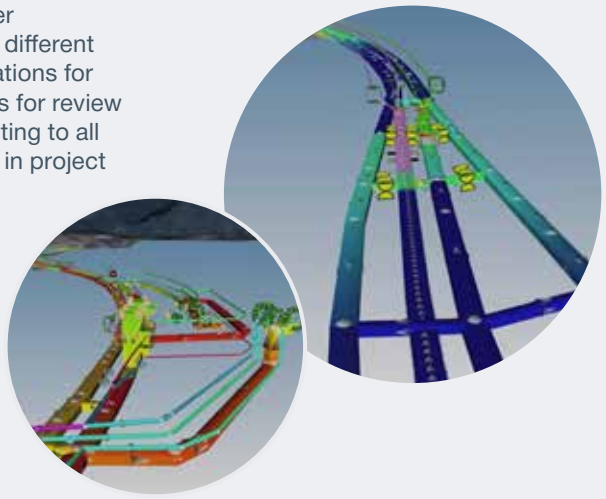
Ventsim is an underground ventilation simulation software package designed to model and simulate ventilation, airflows, pressures, heat, gases, fire and many other types of ventilation data from a model of tunnels.

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.

Access more information on Ventsim Tunnel DESIGN



Ventilation optimisation

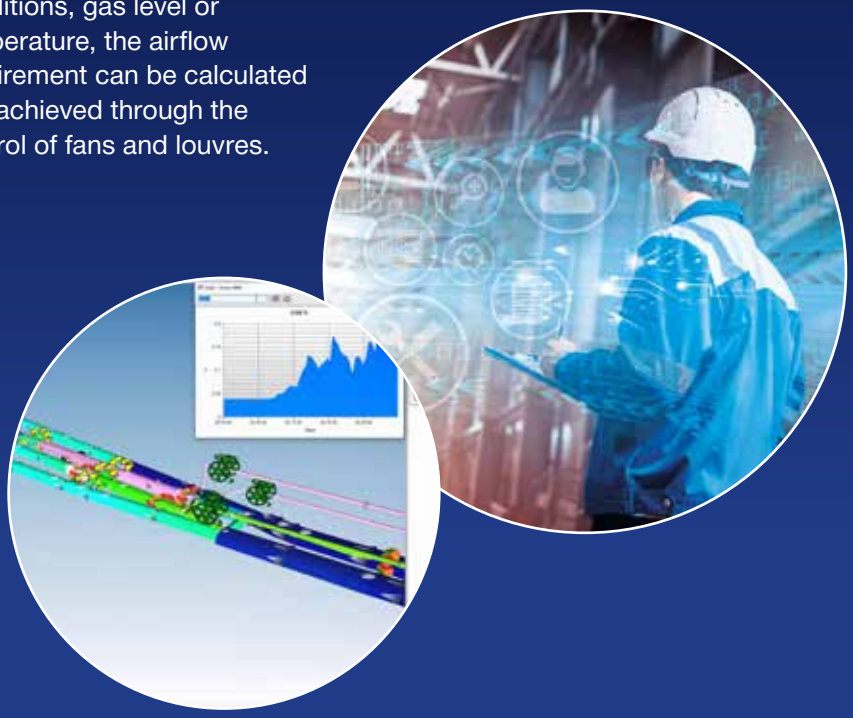
Ventsim CONTROL

Our powerful ventilation on demand software, enables ventilation to be optimised 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 louvres.

Howden Uptime

Howden Uptime provides a unique and innovative platform for gathering, interpreting and analysing 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 **maximise performance**

Aftermarket support

Digital technology combines to optimise fan operation through automated controls and maximise performance.

With access to specialist engineers, we can bring quick resolutions to unexpected issues minimising 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.

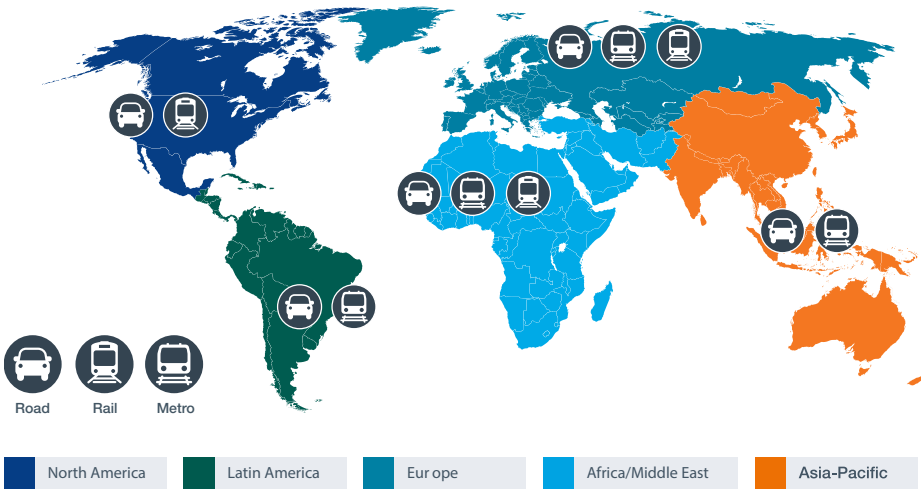
Our range of services includes:

- 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 7,300 fans have been installed in a wide range of road, rail and metro projects globally.

Sample projects

Lötschberg Base Tunnel, Switzerland

The rail tunnel runs a distance of 34.5km under the Bernese Alps. The tunnel design incorporates access and service galleries as well as an emergency stop station in the tunnel.

Ventilation is provided via 3 stations by 9 Howden unidirectional axial fans. The Mitholz and Ferden stations provide fresh air at a rate of 150–200m³/s. The Fystertellä station exhausts fumes at a rate of 250m³/s as well as ensuring potential smoke extraction. Additionally 48 jet fans are located near the south tunnel each 1m in diameter providing 1045N of thrust.

E18 Ekeberg and Svartdals Tunnels, Oslo, Norway

The Ekeberg tunnel is 1580m and Svartdals is formed of a 1460m eastbound and 1700m westbound tunnel. The project was a renovation with the original opening in 1995 and 2000 and included a requirement for 111 jet fans.

The jet fans (uni-directional and fully reversible types) were supplied in 4 different sizes with diameters of 710mm, 1060mm, 1120, and 1250mm. Across these models they provide between 649N to 1650N of thrust supporting continuous ventilation within the tunnels as well as emergency cover.

Metro Moscow, Sokolniki Station, Russia

First opened in 1935 the Sokolniki station has 6 Howden axial fans providing ventilation.

The 1800mm fans (2) are arranged horizontally and produce a flow of 50m³/s (100% bi-directional) with a pressure rise of 500Pa.

Access our reference list

Howden

Make an enquiry through our website

E: tunnel-metro@chartindustries.com

chartindustries.com/howden

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