



VENTIFLEX® VENTILATION SYSTEMS

# THE ART OF TRANSPORTING FRESH AIR

We supply the whole world  
with innovative and efficient  
ventilation systems.

FOR MINES AND TUNNELS

## Protan protects values

Protan is a Norwegian industrial group that is a world-leader in membrane technology. We develop and supply membranes, roof systems, ventilation systems and technical textiles.

Our head office is in Drammen, Norway, and we have more than 650 employees and a total turnover in excess of NOK 1.2 billion.

Our largest business area is roofs and membranes. We have also specialized in tailor-made, flexible ventilation ducts for mines and tunnels. In addition, we supply multi-purpose technical textiles for a range of applications. Protan is also one of the largest roofing entrepreneurs in the Nordic region.

With over 70 years' experience, Protan has developed innovative solutions that are adapted to a global market and demanding climates. We work closely with our customers and supplier to stay at the forefront in technology, the environment and competence. This gives us unique experience and insight that means that we can deliver flexible, tailor-made solutions adapted to local needs - if the customers need waterproof environmental roofing, demanding ventilation or other technical protection.

Our most important role as an international group is to protect values by supplying world-leading solutions.



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# 70 years

When Protan introduced Ventiflex in 1949, we were the first in Europe to provide flexible ventilation ducts for mines and tunnels. Since then, we have built an extensive know-how and broad-based experience that form the basis for today's world-leading products and solutions.

## LONG TERM PEACE OF MIND

All Ventiflex products and ventilation systems undergo Protan's stringent inspection and quality procedures.

## The art of transporting fresh air

Our three flexible ventilation systems, Ventiflex Air, Ventiflex Duo and Ventiflex Shaft, are among the most innovative in the world for mines and tunnels.

### Flame retardant and self-extinguishing

All our systems are made to measure for every project and come in five different duct qualities. All our duct qualities are flame retardant and self-extinguishing. Two duct qualities also have antistatic properties and have been specially developed for environments where highly flammable gases may occur.

### Driving force

We work constantly to drive the development of ventilation technology in mines and tunnels forward. We are members of NTN (Norwegian Tunneling Network), and offer comprehensive training and user support for our Ventiflex customers. We enjoy a close dialogue and good working relationship with our customers, and the training includes installation, suspension and repairs.

### Several hundred kilometres every year

Together with our partners, we supply several hundred kilometres of ventilation ducts every year for mines and tunnels in exciting and demanding projects in Scandinavia, Europe, South America, Asia, Africa and Australia.

### Innovation and environment

We are constantly working to offer the best duct quality through innovation and continuous improvement:

- Excellent durability
- Great flexibility
- Low weight
- Simple handling

We always focus on health and safety. The materials used in our ventilation ducts are therefore flame retardant, self-extinguishing and resistant to chemicals. All our ventilation ducts are recyclable and come in a colour that reflects light in tunnels and mines.

### Production and quality assurance

Ventiflex is manufactured at our two factories in Norway. The coated textile is produced in Drammen, while the ducts are made in the factory at Nesbyen. Our factories and ventilation systems are approved and certified in accordance with ISO 9001 for quality and ISO 14001 for environmental management. This means that our entire value chain and all our ventilation solutions are documented as being of a high standard and having a minimal impact on the environment, both locally and globally.

### Development and testing

We develop and test all our solutions and qualities at our laboratory in Drammen. It is approved by Det Norske Veritas (DNV) and follows strict testing and documentation procedures. All our systems undergo exhaustive inspection and quality control prior to delivery.

### 2.5-kilometre test tunnel

We also carry out testing in a real tunnel environment so as to guarantee the quality of our products and solutions. Among other things, we have access to a 2.5-kilometre test tunnel, which we use to improve our duct systems.



- Quick to install
- Easy to maintain
- Customised
- Great flexibility

## DETAILS THAT COUNT

Our couplings cover a variety of underground ventilation applications, and offer great flexibility and customisability.

### PROTAN VENTIFLEX AIR

## A world class ventilation concept

Protan Ventiflex Air is a concept for mines and tunnels in which membrane materials, coupling types and welding technology combine to create a world-class ventilation duct system.

Ventiflex Air was the first flexible ventilation system to be developed and manufactured in Europe. All five of our duct qualities in this series are based on many years of experience, aerodynamic expertise and extensive product development.

#### Specially developed PVC membrane

The duct qualities in the Ventiflex Air series are developed and manufactured in a membrane specially developed for ventilation ducts. The reinforced polyester textile is produced at our own plant in order to ensure that it has the right properties. The textile, and therefore the membrane, is stronger radially than axially owing to its air pressure characteristics.

#### Optimised strength

The polyester textile is knitted, not woven, so as to minimise the length and size of any damage or tears. The textile is coated with strong PVC, which helps to optimise strength and prevent delamination when it is exposed to high pressure and stress. Should damage nevertheless occur, we have the expertise and experience to carry out the vast majority of repairs in the field without any reduction in the quality or capacity of the ventilation system.

#### Fully automated welding system

A fully automated welding system means that we can supply every duct diameter from  $\varnothing 200$  mm to  $\varnothing 3,200$  mm in any length. A continuous suspension rib running the length of

the duct with pvc eyelets every 50 cm improves air flow and ensures a high capacity. Practical tests on our duct systems confirm both their quality and our ability to deliver results that are better than the figures in the SIA 196 standard's S class.

- Ventiflex delivers fresh air in to mines and tunnels all over the world.





**Lower energy consumption**  
**Up to 40% more headroom**  
**Two independent standard ducts**

PROTAN VENTIFLEX DUO

## For narrow passages

Protan Ventiflex Duo is a concept that has been developed to transport air through narrow passages or in tunnels with limited headroom without compromising the air flow.

The idea is simply to substitute the main duct, with two smaller diameter ducts, through a transition piece, not compromising on air volume and other capabilities of the designed ventilation system.

**Less energy consumption**

Protan Ventiflex Duo has a larger cross-section than other similar systems, which means lower energy consumption for the same installation height and fan output. It also delivers more air to the face with the same fan output.

**Two independent ducts**

The two standard ducts are independent, and are utilizing all the standard coupling systems. The advantage is obvious, the duo-duct has no conceptual limitations for the total duct-length installation.

**DID YOU KNOW THAT..**

... **in the old days**, birds were used as an early warning system in mines? If the bird in the cage hanging in the gallery stopped twittering, there was clearly not enough oxygen and the miners would have to get out.



### ENOUGH AIR

Protan Ventiflex Duo transports air into mines and tunnels with limited headroom without reducing air quality.





Solutions for challenging requirements  
 Fully supported on two-four wire ropes  
 Flexible airtight joints

**AN INTELLIGENT SOLUTION**

How can fresh air be supplied through vertical passages? The answer is Protan Ventiflex Shaft!



PROTAN VENTIFLEX SHAFT

## Vertical supply of fresh air

Protan Ventiflex Shaft has been developed for the vertical supply of fresh air through a shaft construction.

Some underground constructions require supply of fresh air through vertical shafts. To accommodate this challenge, Ventiflex can supply a shaft-ducting system, designed to meet the unique demands such a system requires.

Present day, the deepest installation is 1,400 meters from the surface, expressing the quality and reliability of our design.

**Flexible solutions**

Protan Ventiflex Shaft is made with two, three or four suspension ribs, which are secured to wires using special non-slip hooks and clips. There is a turnbuckle at one end of the wire to ensure correct alignment. Our solutions are flexible, and we supply duct lengths for both excavation and static installations. We also offer any duct diameter from ø200 mm to ø3,200 mm in all duct lengths.

*In the worst case, a lack of fresh air in mines and tunnels can bring the project to a standstill.*



## PRODUCTS FOR VENTIFLEX

### VENTIFLEX DUCT QUALITIES

All five of our duct qualities are:

- Flame Retardant – FR
- Self-extinguishing

Two of our duct qualities also have antistatic properties (Anti Static – AS). Antistatic duct qualities are ideal for coal mines and tunnels where gaseous conditions may occur. The choice of duct quality is dictated by the working air pressure calculated for the ventilation system. We supply duct lengths to specification for all qualities and diameters. All ducts are supplied standard in yellow, apart from antistatic ducts, which are in light grey. Other colours are available on request.

| PRODUCT NAME                  | DIAMETER          |
|-------------------------------|-------------------|
| Protan Ventiflex Air 6212FR   | 200 mm – 3,200 mm |
| Protan Ventiflex Air 6298FR   | 200 mm – 3,200 mm |
| Protan Ventiflex Air 6698FR   | 200 mm – 3,200 mm |
| Protan Ventiflex Air 7111FRAS | 200 mm – 3,200 mm |
| Protan Ventiflex Air 7198FRAS | 200 mm – 3,200 mm |

For help choosing the right duct quality for your needs, email us at: [ventiflex@protan.no](mailto:ventiflex@protan.no)

### VENTIFLEX DETAILS – TO OPTIMISE AIRFLOW

All Ventiflex fittings have been developed to optimise airflow in accordance with the laws of aerodynamics and are produced in the strongest duct quality to withstand high stress. Our fittings come in all diameters and for all coupling systems. Ventiflex fittings can be customised to specification for more extreme ventilation duct installations to ensure optimum airflow, in example long duct installations.

| Y-PIECE   | T-PIECE   | BEND   |
|---|---|--|
|  |  |  |
| BRANCH  | ADAPTERS, REDUCERS AND EXPANDERS  |  |
|  |  |  |

### VENTIFLEX COUPLINGS – GREAT FLEXIBILITY

Our range of couplings covers a variety of underground ventilation applications in mines and tunnels. The couplings contribute to the ventilation system's great flexibility and adaptability. All our coupling systems are high quality and feature industrial quality design.

- Easy to install
- Minimal leakage under high pressure
- Reusable
- Long life and good durability

Protan Ventiflex offers four standard coupling systems:

| VF COUPLING   | FLEX JOINT  | ZIP COUPLING  | VELCRO COUPLING   |
|---|---|---|---|
|  |  |  |  |

### VENTIFLEX SUSPENSION HOOKS – FOR MANY ENVIRONMENTS

The industrial design of our suspension hooks and the range we offer have been developed on the basis of many years of experience to cover a variety of environments and situations in underground ventilation systems. Our hooks are dimensioned to withstand high tensile stress caused by powerful external winds, internal turbulence and vibrations in the duct system. Every Protan Ventiflex hook system has its advantages:

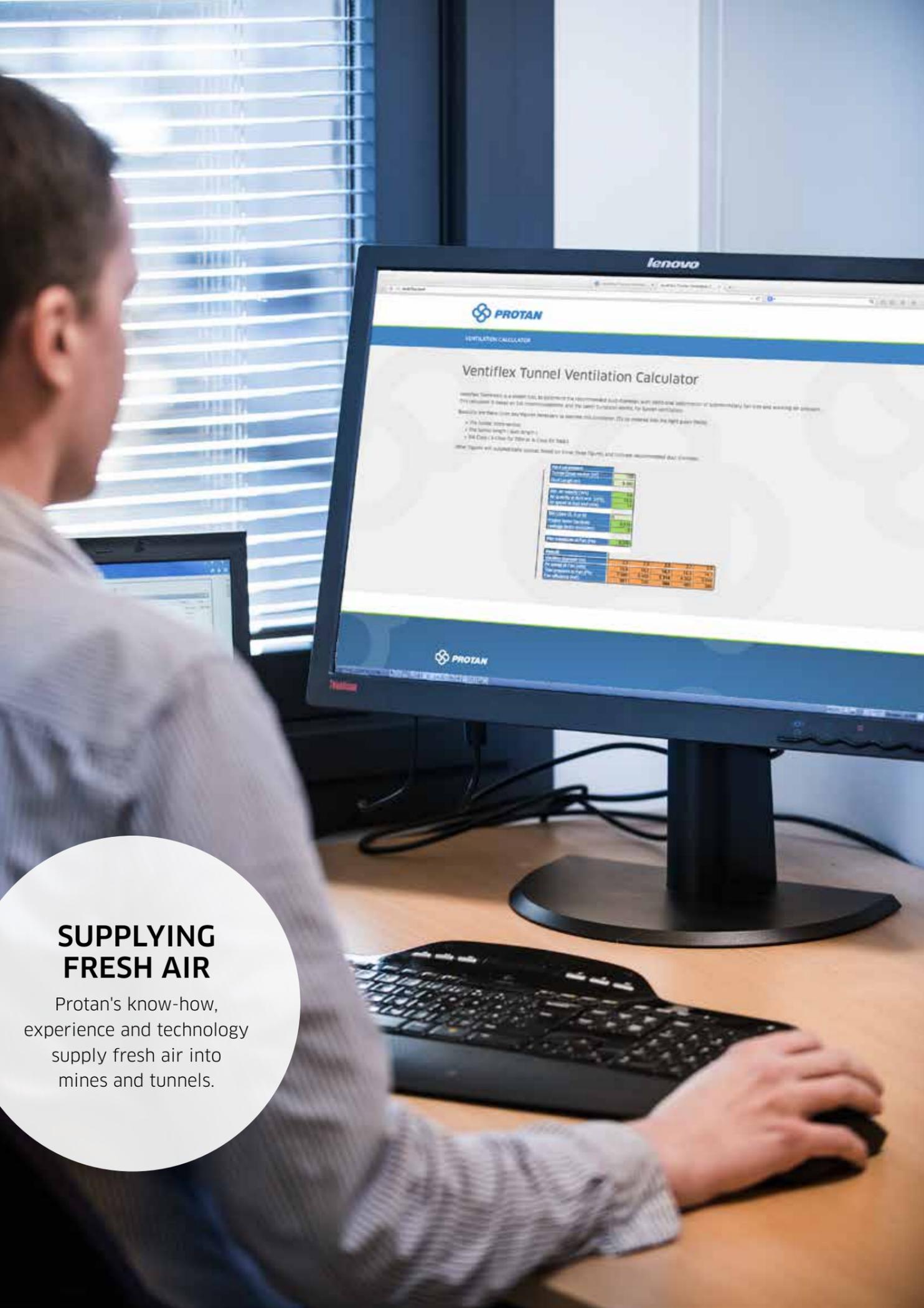
| PROTAN VENTIFLEX VF HOOK   | PROTAN VENTIFLEX SNAP HOOK   | LP HOOK  |
|--|--|--|
|   |   |                                     |
| The Protan Ventiflex VF hook has a 380 mm wire attached for alignment purposes in drill-and-blast (D&B) tunnels and mines. This hook is also essential in pur Duo-duct system. | Protan Ventiflex snap hooks are used for fast installation and dismantling. For many customers this is their preferred hook in TBM-driven tunnels. | Protan Ventiflex LP hooks are easy to attach straight to the suspension wire when there is no need to adjust the height. |

### MAINTENANCE – FOR A GOOD, SAFE WORKING ENVIRONMENT

We recommend a few simple maintenance measures to ensure long-term, efficient operation of the ventilation system.

- Check that the installation instructions have been followed
- Check that couplings and adaptors are airtight
- Check that suspension hooks are not stuck to the installation wire
- Check the ventilation ducts for tears

Simple maintenance ensures a good, safe working environment and contributes to reducing energy costs. The size of the ventilation ducts and fan is precisely calculated on the basis of set parameters. To maintain the desired air quality throughout the project, it is important that the system is not compromised by damage or installation errors.



VENTIFLEX VENTILATION CALCULATOR

# Easy to use for your project

The Ventiflex Ventilation Calculator is a simple tool for calculating the recommended diameter of ventilation ducts for a tunnel project.

The calculator also gives recommended fan size and expected air pressure for supplying the necessary fresh air to the face. The calculator is based on SIA recommendations and current European standards for tunnel ventilation. That is why the return air velocity is automatically set to 0.5 m/s.

**Three key parameters**

You only need to specify three key parameters for the calculator to do the sums:

- Tunnel cross-section
- Tunnel length
- SIA class

With the quality offered by Ventiflex, we recommend using class S for TBM tunnels and class A for conventional D&B tunnels.

**Guide**

The Ventiflex Ventilation Calculator is a guide. In most cases it will therefore be necessary to carry out a more detailed calculation to check that the ventilation requirement has been dimensioned correctly.

## SUPPLYING FRESH AIR

Protan's know-how, experience and technology supply fresh air into mines and tunnels.



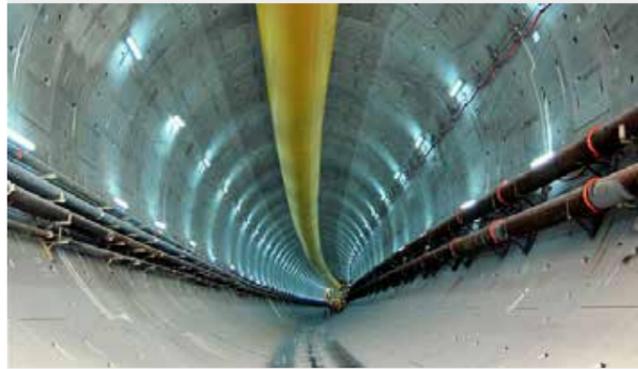
The Ventiflex Ventilation Calculator can be found at [protan.com/ventiflexcalculator](http://protan.com/ventiflexcalculator) Or scan this QR code:



*You only need to specify three key parameters for the calculator: Tunnel cross-section, length and SIA class.*

## REFERENCE PROJECTS

### THE BOSPORUS IN TURKEY



**Application:** Tunnel  
**Ventiflex system:** Protan Ventiflex Air  
**Product:** 6212FR  
**Size:** 5.4 km long, 2.5 m in diameter  
**Location:** Istanbul, Turkey

**Ventiflex is supplying the tunnel under the Bosphorus** with fresh air throughout the construction period. The tunnel connects the European peninsula with Asia and is expected to be used by 120,000 vehicles daily.



For more reference projects  
[protan.com/ventiflex](http://protan.com/ventiflex)

### INNSBRUCK IN AUSTRIA



**Application:** Tunnel  
**Ventiflex system:** Protan Ventiflex Air  
**Product:** 6212FR and 6298FR  
**Size:** 26.1 km long, several different diameters  
**Location:** Innsbruck, Austria

**The project is part of the Brenner Base Tunnel SE (BBT)**, the new rail link between Verona and Munich. The contract will run until 2019 with an option to extend up to 38 km.

### RYFAST IN ROGALAND, NORWAY



**Application:** Tunnel  
**Ventiflex system:** Protan Ventiflex Air  
**Product:** 6212FR  
**Size:** 20 km long, 2.4 m in diameter  
**Location:** Rogaland, Norway

**Ryfast is a ferry-free road link** between Stavanger and Strand. The tunnel, which is being built from both ends simultaneously, will be 20 km long and run 290 metres below the surface of the sea. Scheduled completion 2018.

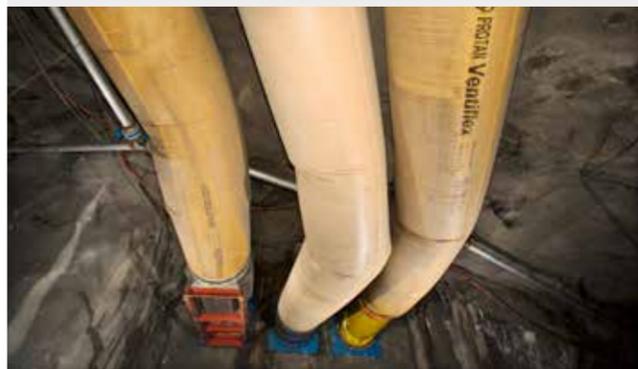
### MINES IN SWEDEN



**Application:** Mine  
**Ventiflex system:** Protan Ventiflex Air  
**Product:** 6298FR  
**Size:** Various lengths and diameters  
**Location:** Sweden

**These activities involve contracts for zinc and copper mines in Sweden.**

### HONG KONG IN CHINA



**Application:** Tunnel  
**Ventiflex system:** Protan Ventiflex Air  
**Product:** 6212FR  
**Size:** 20 km long, 2.5 m in diameter  
**Location:** Hong Kong, China

**Ventiflex is supplying fresh air** during the expansion of the large-scale infrastructure investment in Hong Kong. We have contracts for the Liantang and Tuen Mun projects.

### MINES IN AFRICA



**Application:** Mine  
**Ventiflex system:** Protan Ventiflex Air  
**Product:** 6212FR and 6298FR  
**Size:** Various lengths and diameters  
**Location:** Zambia

**Ventiflex is used in mines in Zambia**, where the world's largest copper deposits are found.



## Environment and sustainability

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**Our objective is to reduce the total consumption of resources in our value chain. Our products are manufactured in Norway from eco-friendly, REACH-approved raw materials using Norwegian hydropower. They are manufactured, used and managed with minimal resource use.**

Protan's quality and environmental management systems conform to ISO 9001 and ISO 14001 respectively.

Our products and production are independently inspected by various accredited testing bodies in the countries where Protan Ventiflex is used.



For more information  
visit: [protan.com](http://protan.com)

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