systemair

Tunnel Ventilation Technology

by MRT TEAM

European approach

- April 2004 Release of ED 2004/54/CE relevant to TEN (Trans Europe Network) road tunnels. Minimum safety requirements.
- Previously in 2001 European Commision promoted SAVE. Program on energy saving. Results shown in an official Report pubblished in the same year.
- Relevant to underground systems a possible target of 4 TWh/annum reduction could be achieved. The reduction equates to 1,6 million tons of CO_2.

Piarc Approach

- The Permament International Association of Road Congress have always been active in the energy savings in the ventilation systems.
- Currently the Working Group 1, Technical Committee C 3.3 is working on a document that it will presented during the next World Congress in Seoul, KR, November 2015.
- Sustainable Road Tunnel Operation (Draft 3 April 2014).

Main focuses:

- Alternative energy sources
- Improved or more efficient equipements
- Improved or more efficient solutions
- Encourage use of electrical inverters

Road Tunnels

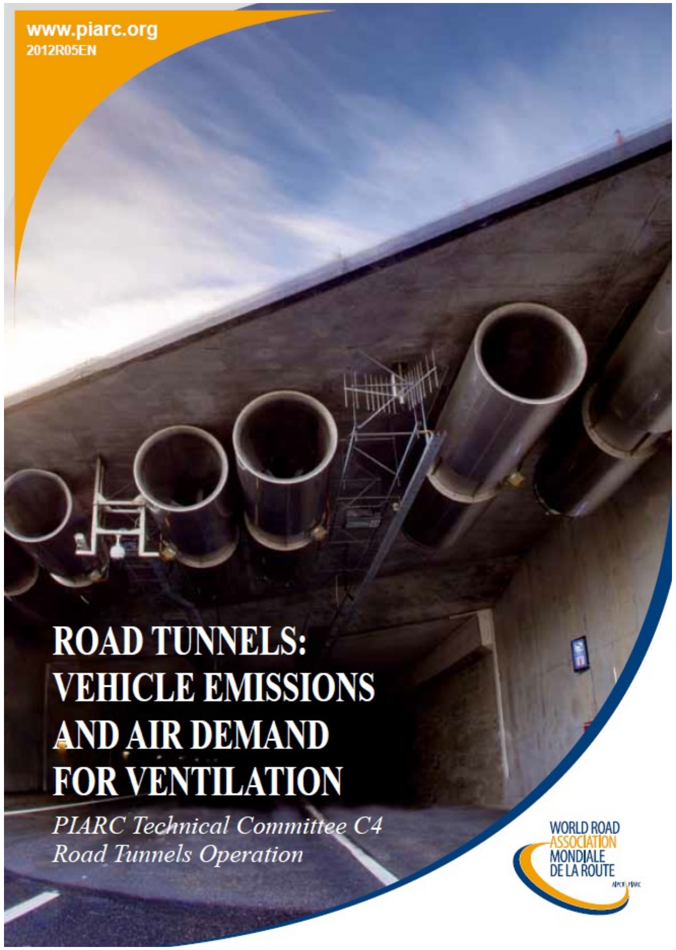
Road Tunnels

Ventilation requirements

Pollution control for comfort & safety

Smoke control in case of fire

Pollution – Calculation of Fresh Air



POLLUTION CONTROL

- PIARC – 2012R05EN

Fire Emergency – Calculation of required Jet Fans

Fire Emergency

- PIARC – 05.16.B
- PIARC – 05.05.B

Association mondiale de la Route

World Road Association

SYSTÈMES ET ÉQUIPEMENTS
POUR LA MAÎTRISE
DES INCENDIES ET DES FUMÉES
DANS LES TUNNELS ROUTIERS

SYSTEMS AND EQUIPMENT
FOR FIRE AND SMOKE CONTROL
IN ROAD TUNNELS

2007

Comité AIPCR de l'Exploitation des Tunnels routiers (C3.3)
PIARC Committee on Road Tunnels Operation (C3.3)

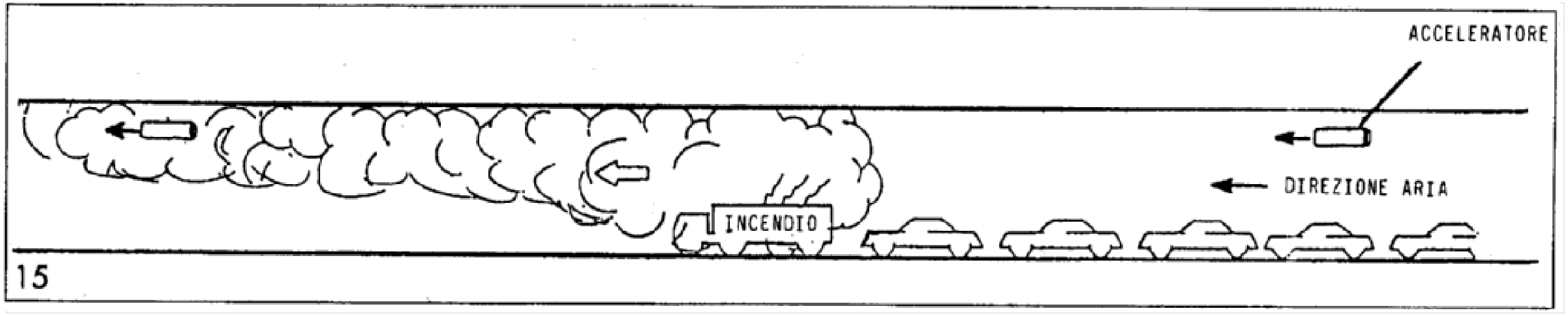
MAITRISE DES INCENDIES
ET DES FUMEES
DANS LES TUNNELS ROUTIERS

FIRE AND SMOKE CONTROL
IN ROAD TUNNELS

05.05.B

Comité AIPCR des Tunnels routiers (C5)
PIARC Committee on Road Tunnels (C5)

Critical Velocity



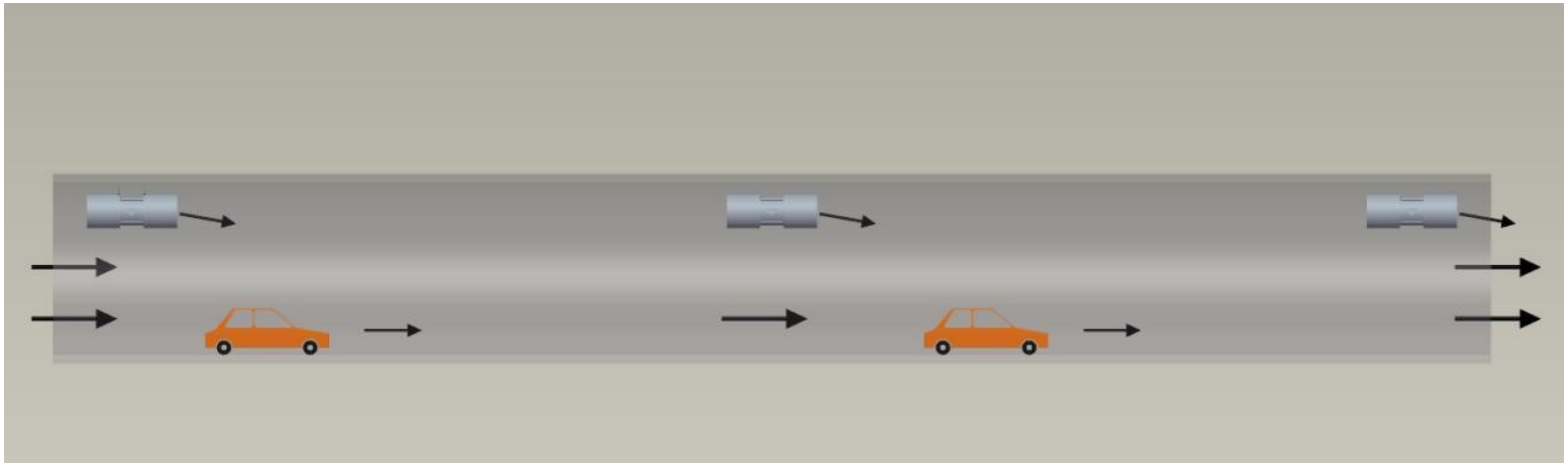
The critical velocity, Vc, is the minimum steady-state velocity of the ventilation air moving toward a fire that is necessary to prevent backlayering

$$V_c = K_1 K_g \left(\frac{gHQ}{\rho C_p A T_f} \right)^{1/3}$$

$$T_f = \left(\frac{Q}{\rho C_p A V_c} \right) + T$$

Note: $V_c \leq 3 - 3.5$ m/s
for standard calculation 3 m/s is used due to missing parameters in formula

Longitudinal Ventilation



Jetfans installed the tunnel generate an airflow so that air enters one portal and is discharged at the other portal.

Pressure losses

Tunnel longitudinal ventilation

- It works on an induction principle
- It is based on exchange of momentum (mv) between jetfans and tunnel air
- Thrust generated by jetfan induces fresh air into tunnel

Tunnel Losses – Required Thrust

Tunnel Losses	xxx Pa
Piston Effect (+/-)	xxx Pa
Metereological Effect	xxx Pa
Other Losses	xxx Pa
Total Losses	xxx Pa

$$Pa = N/m^2$$

(Total Losses) x (Tunnel Face Area) = Force

$$N/m^2 \quad x \quad m^2 \quad = \quad N$$

Force = Thrust

Trust of jetfan

Theoretical thrust

$$T_f = \rho \cdot q_v \cdot V_f$$ [N]

Real thrust

ISO 13350

Thrust in the tunnel

$$T_t = \rho \cdot q_v \cdot (V_f - V_t)$$ [N]

Total trust in the tunnel

$$T_f = \frac{T_t}{(1 - \frac{V_t}{V_f})}$$

[N]

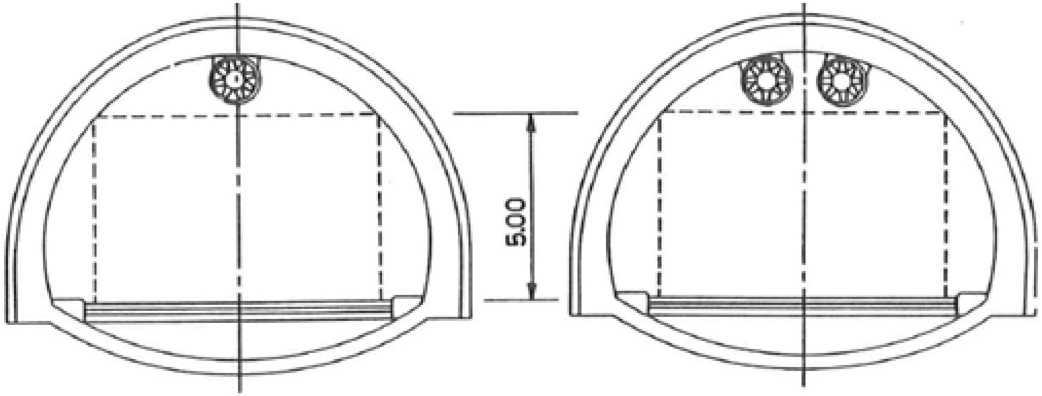
Total jetfan thrust in the tunnel with jetfan installed:

$$T_f = \frac{T_t}{k \cdot (1 - \frac{V_t}{V_f})}$$

[N]

Tipical Installation

- Normally JET fans or Booster fans
- Installation close to the tunnel surface



Typical single fan location. Typical location of two fans.

systemair

Total trust in the tunnel

- k = can be as lower as 0.65

- $\frac{V_t}{V_f}$ influence up to 0.8

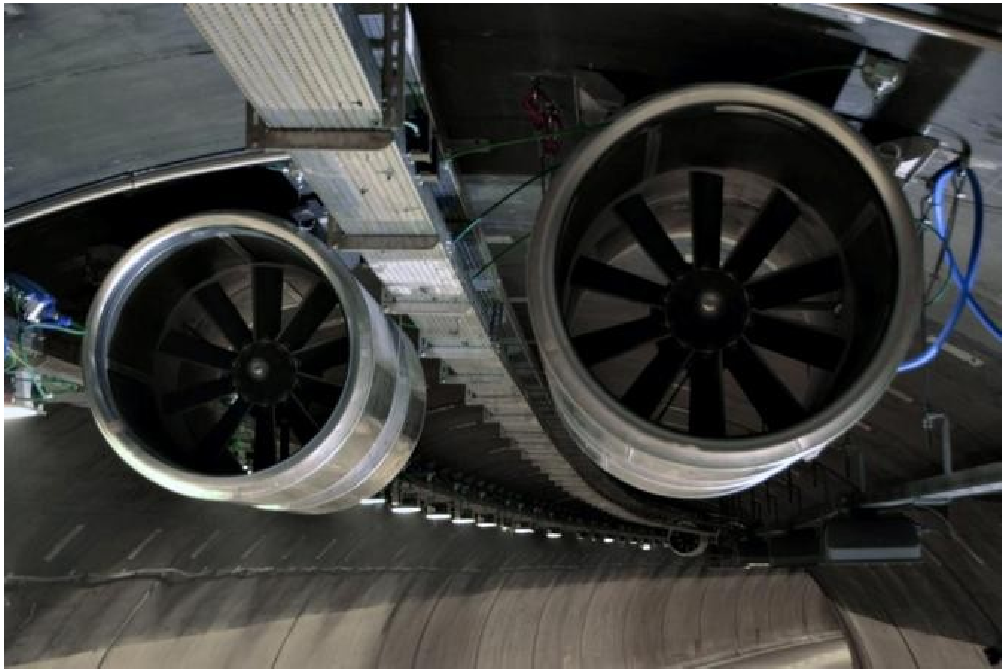
Mechanical Longitudinal Ventilation Equipment

systemair

Jetfans

<u>BENEFITS FOR USER</u>

- High efficiency
- Low noise operation
- Robust and durable
- High operating reliability
- Low maintenance
- Reliable corrosion protection
- Reversible Flow
- EN 12101-3 Certification up to 400°C/2h



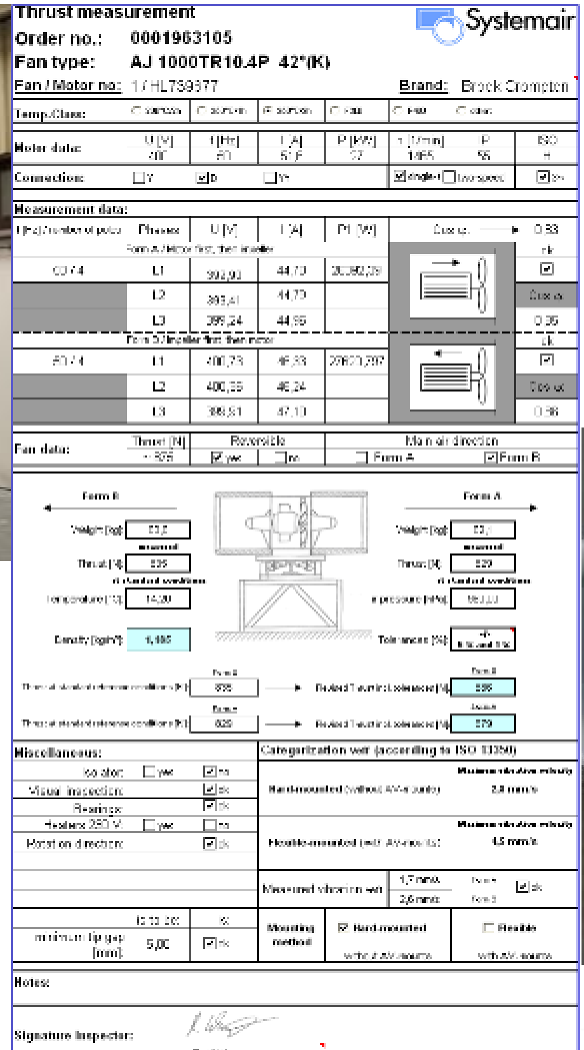
Jetfans

BENEFITS FOR CONTRACTOR

- Easy to install
- Wide ancillaries range
- Global services network
- Adaptable requirements
- Technical support

Longitudinal System Components

Jetfan Performance Testing



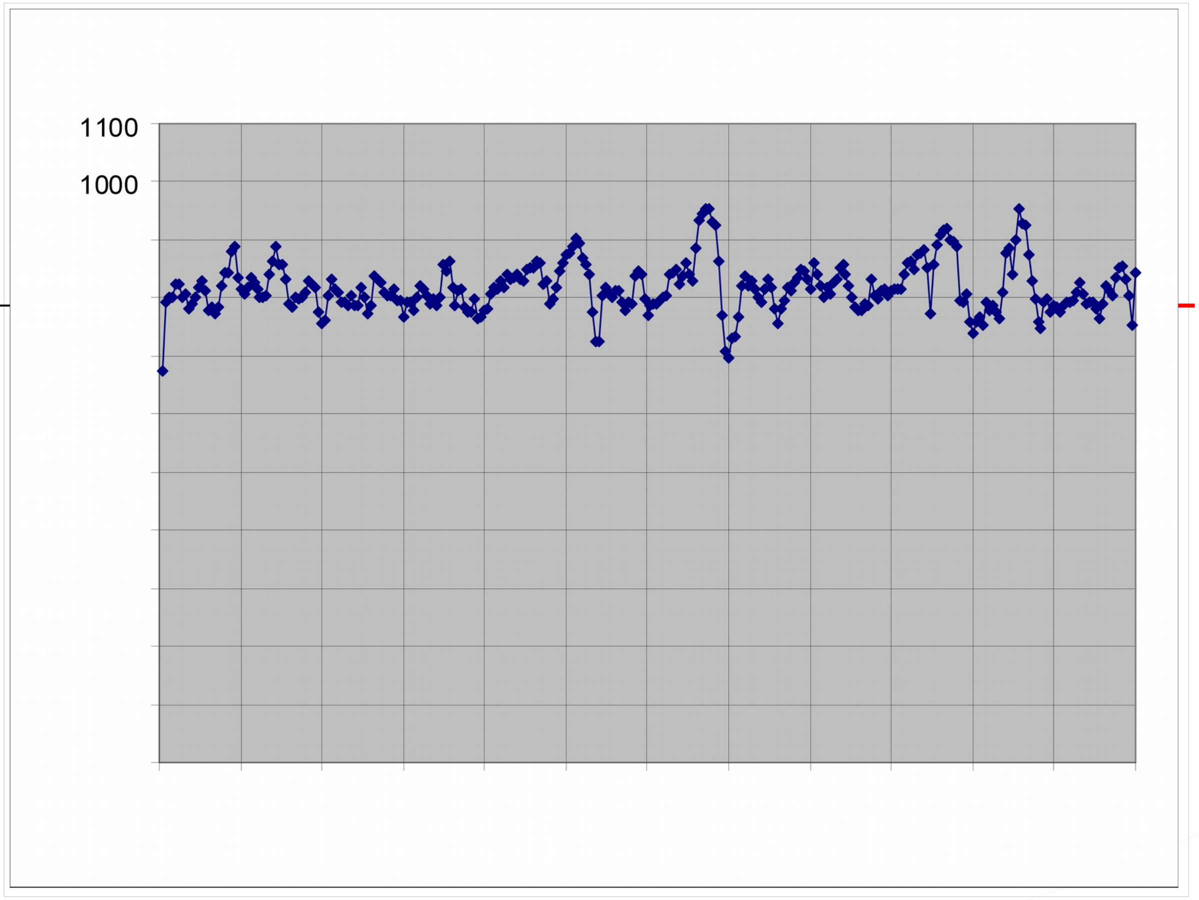
Thrust Test as per ISO 13350

Acoustic Test as per ISO13350

Thrust measuring

Sample diagram

Recorded and converted values of the force transducer



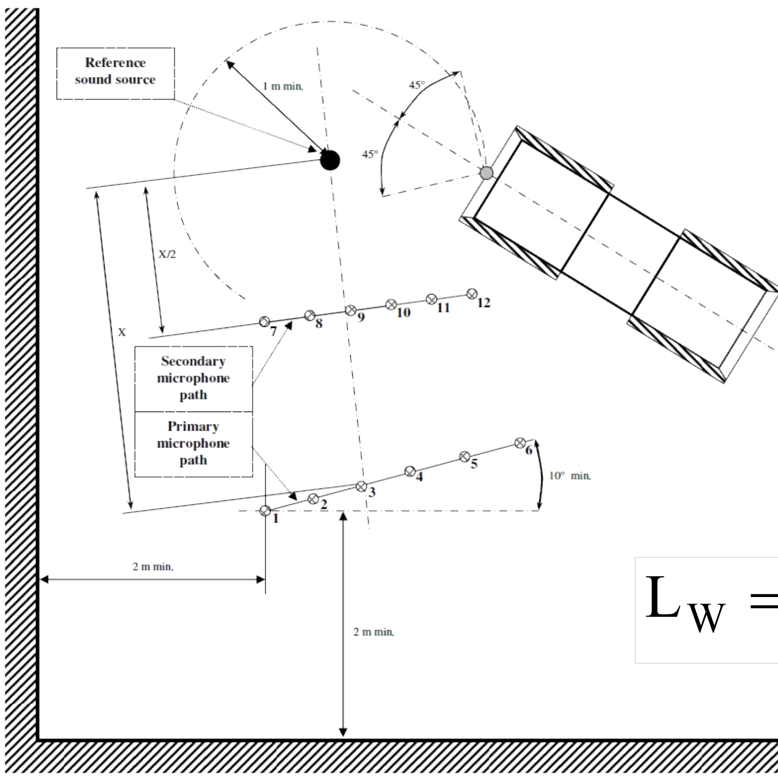
The average thrust will be shown as result

systemair

Sound measurement of Jet fans

Sound measurement of jet fans according to …

… DIN EN ISO 13350 as an Independent test setup



$$L_W = L_{p(m)} - L_{p(r)} + L_{W(r)}$$

systemair

Overview standards used

<u>Air performance measurements on our inlet test chambers</u>

Small test chamber → ISO 5801 (Industrial fans – Performance testing using standardized airways)

Big test chamber → AMCA 210-07 (Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating)

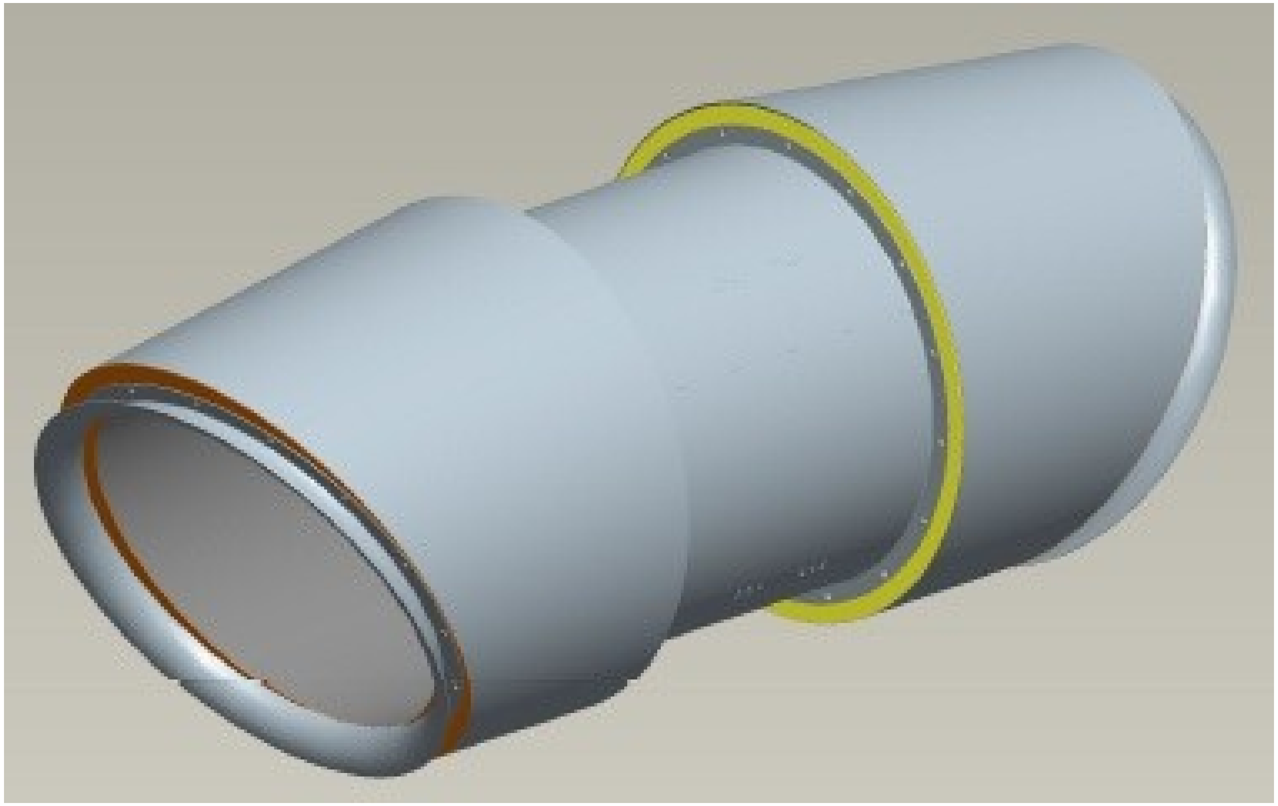
<u>Air performance measurements on our inlet tube test rigs</u>

Both tube test rigs → AMCA 210-07

<u>Thrust measurements and sound measurements of jet fans</u>

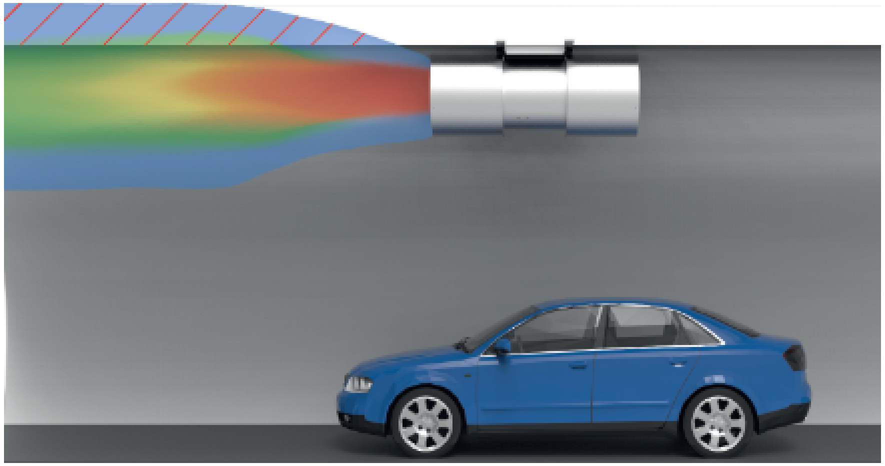
Test rig / sound setup → DIN EN ISO 13350 (Industrial fans – Performance testing of jet fans)

MoJet®



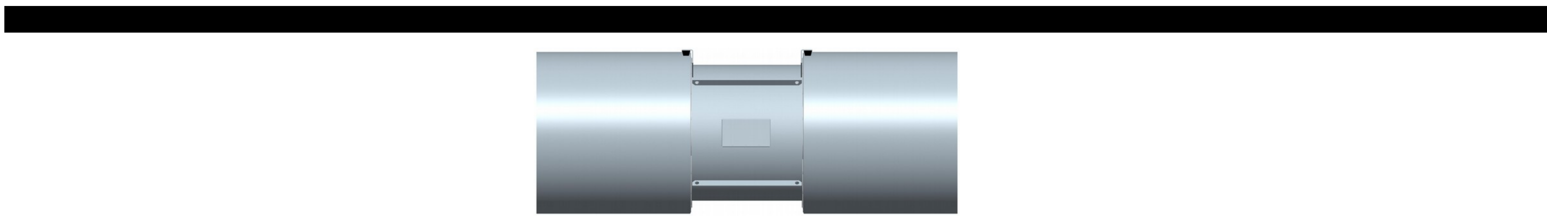
MoJet®

- MoJets® combine the advantages of jetfans and Saccardo
- The sagomated silencers (inclined cutted outlet) are installed on one or both sides of a fan
- The upper part of the silencer is inclined towards the tunnel centreline, enhancing the installation efficiency

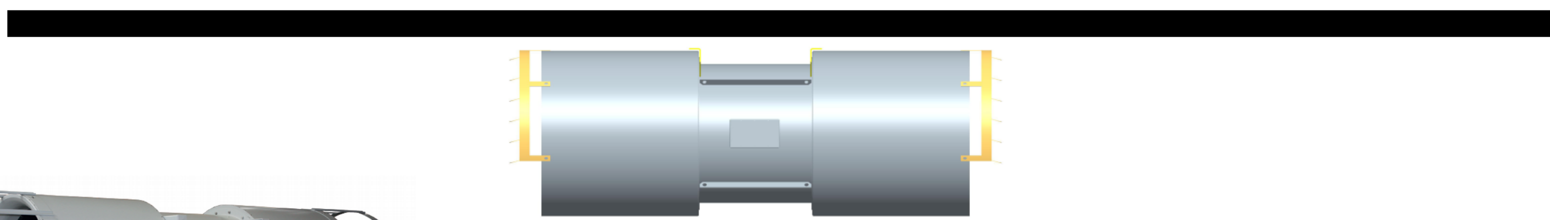


Tunnel Ventilation – System components

MoJet® - Installation factors



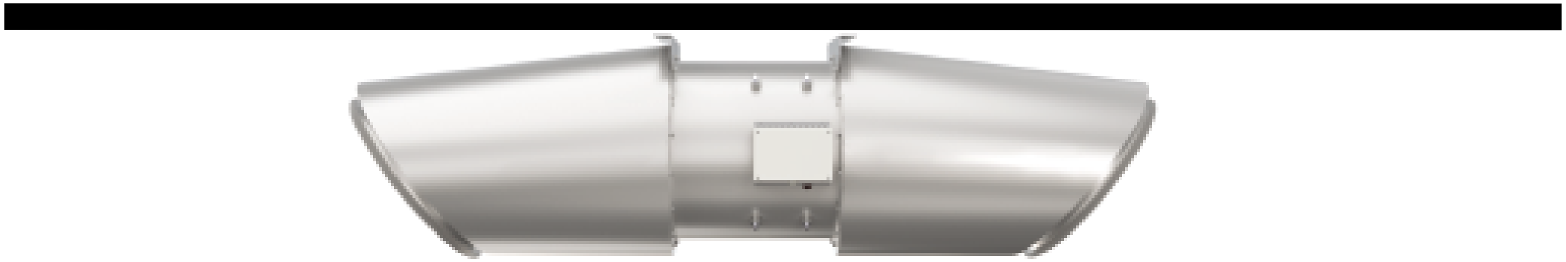
Installation Factor ~ **0,70**



Installation Factor ~ **0,75**
Power increases ~ **5%**
Noise level remarkably increases

No power increases

MoJet®



Installation Factor ~ **0,94**
No power increases

Tunnel Ventilation – System components

MoJet® Advantages

– Significantly enhanced thrust

– Reduced power requirements

– Smaller diameter fans can be selected for the same installed thrust as conventional jet fans

– No encroachment of traffic envelope

– Can be installed very close to tunnel walls and soffits, reduced space requirements

– Reduced cabling costs using

– Reduced maintenence costs (less units).

–Reduced running cost.

–Better LCC

Thanks for your attention!