

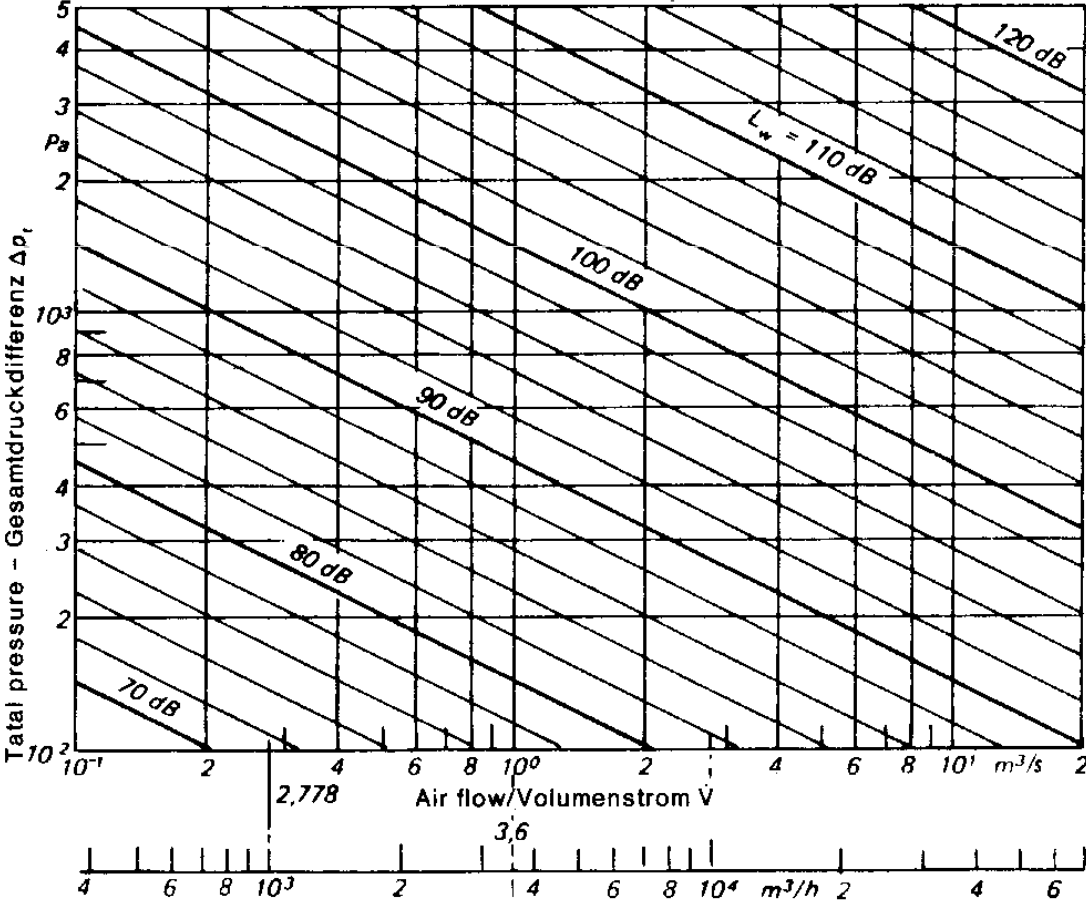
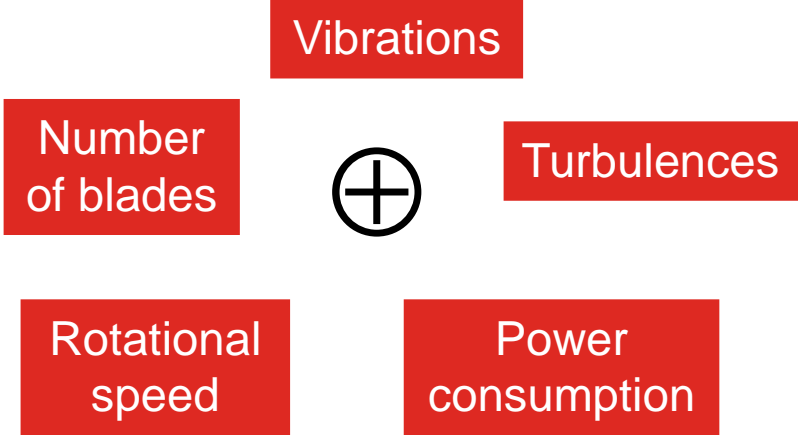
Noise Generation & Attenuation

Noise Generation & Attenuation

1. General
2. Jet fans
3. Axial Fans

General

Sound Power L_w depends on



Sound power as a function of fan capacity and pressure at η_{max} .

Sound Pressure $L_{P,r}$:

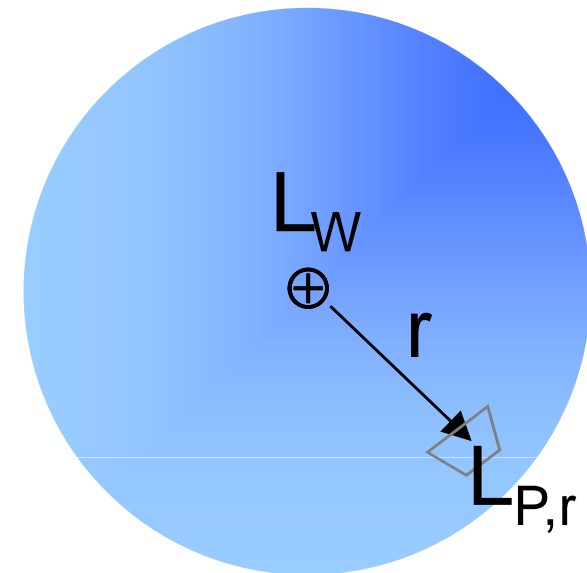
depends on distance r from source L_W

→ Think of a soap bubble
(constant amount of soap)

The larger the bubble
becomes (r) ...

the thinner the thickness
of the sphere becomes

→ The thickness of the sphere
is proportional with $L_{P,r}$



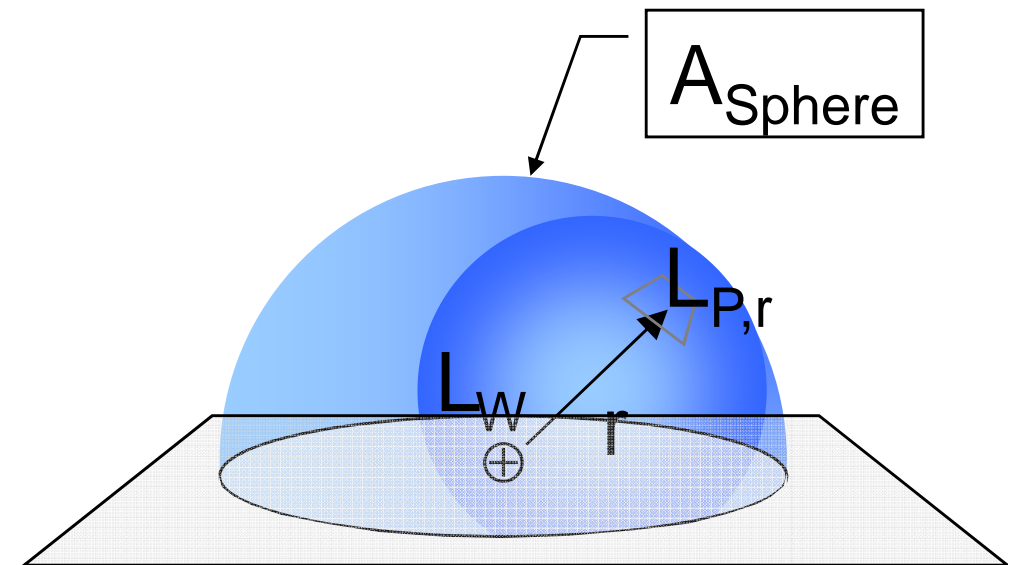
Sound Pressure $L_{P,r}$:

$$L_{P,r} = L_W - L_{A_{\text{Sphere}}}$$

$$L_{P,r} = L_W - 10 \cdot \log(A_{\text{Sphere}})$$

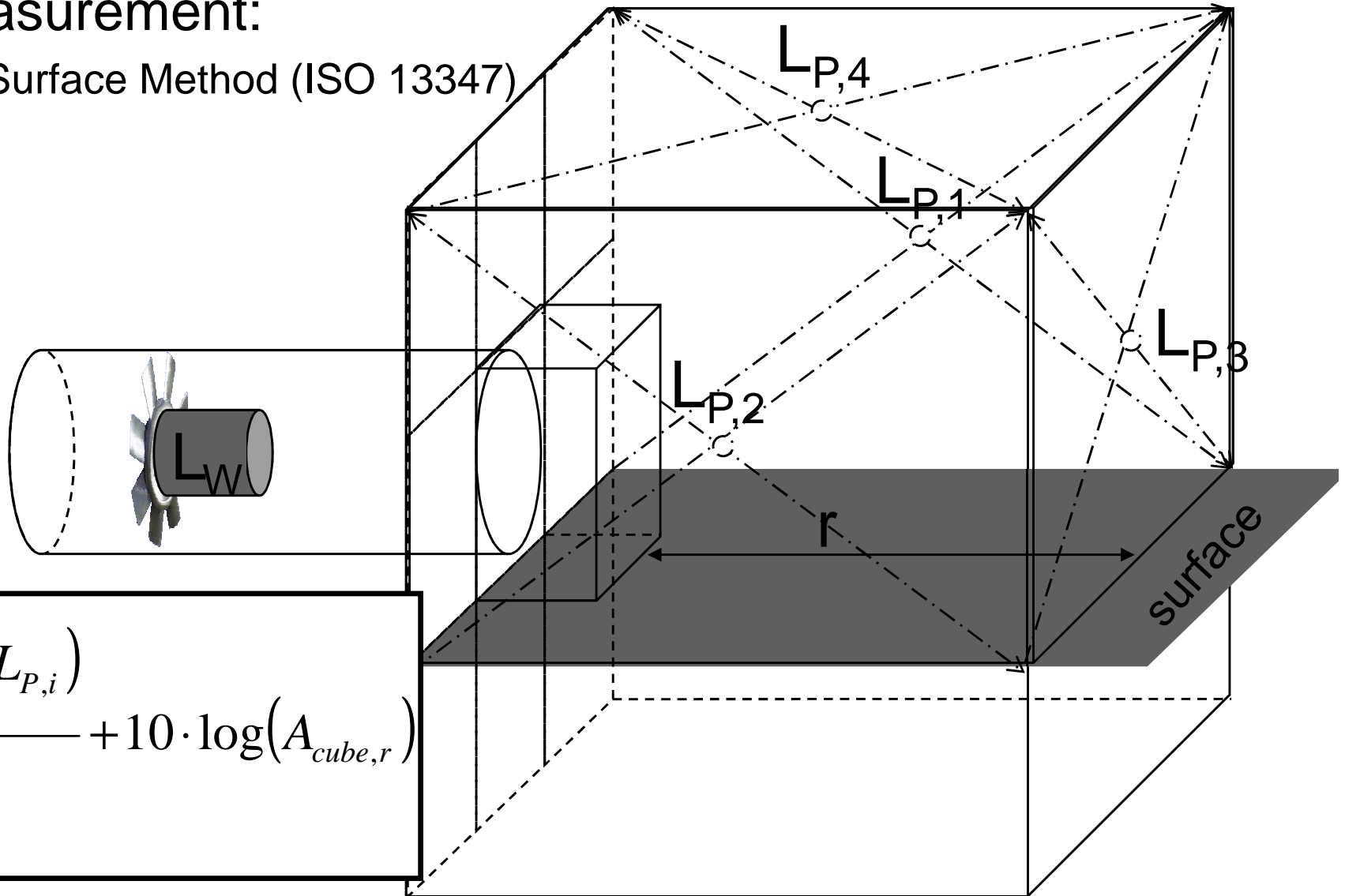
$$A_{\text{Sphere}} = 4 \cdot \pi \cdot r^2$$

$$A_{\text{Semi-sphere}} = 2 \cdot \pi \cdot r^2$$



Sound Measurement:

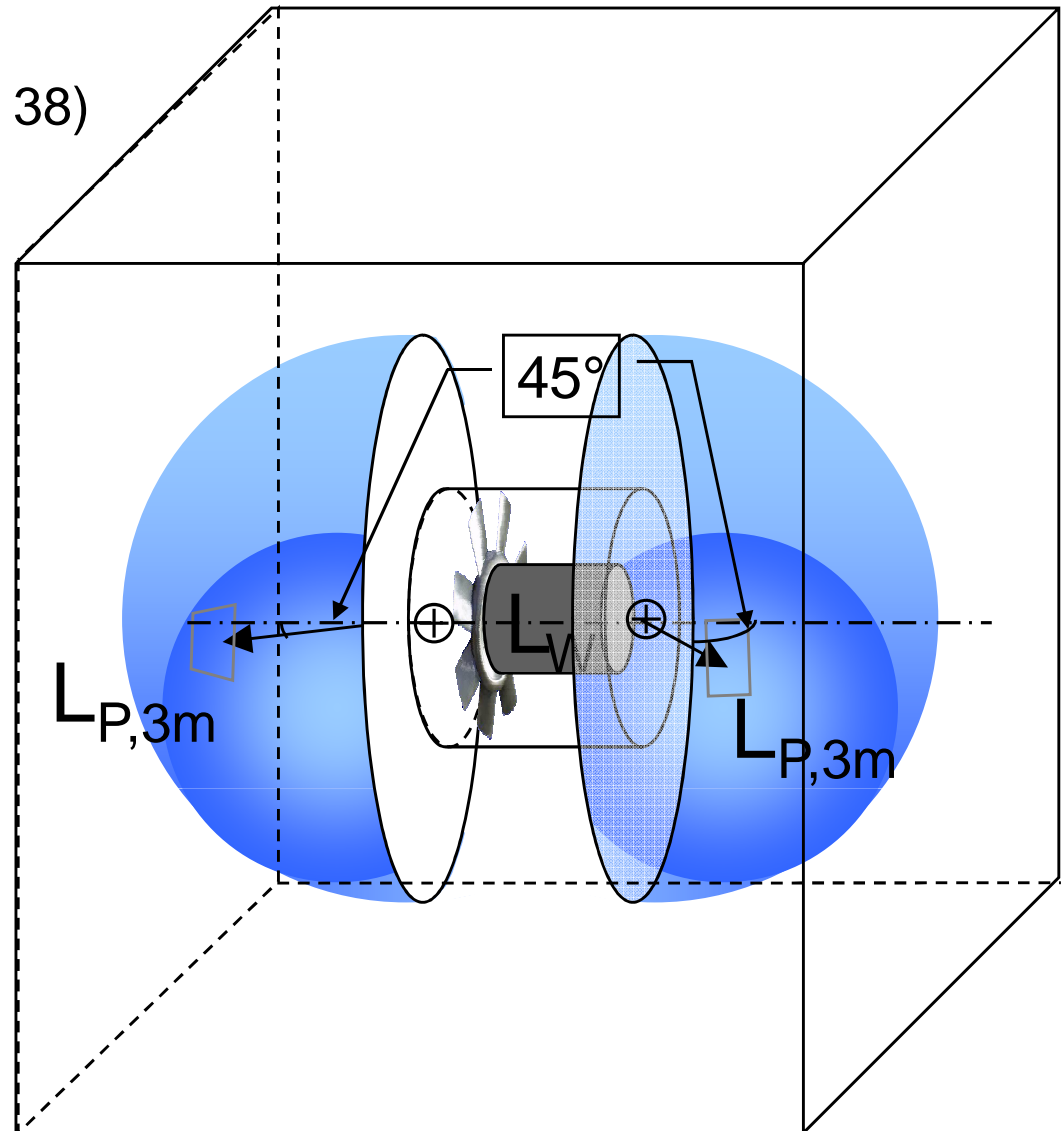
- Envelope Surface Method (ISO 13347)



$$L_W = \frac{\sum_{i=1}^n \log(L_{P,i})}{n} + 10 \cdot \log(A_{cube,r})$$

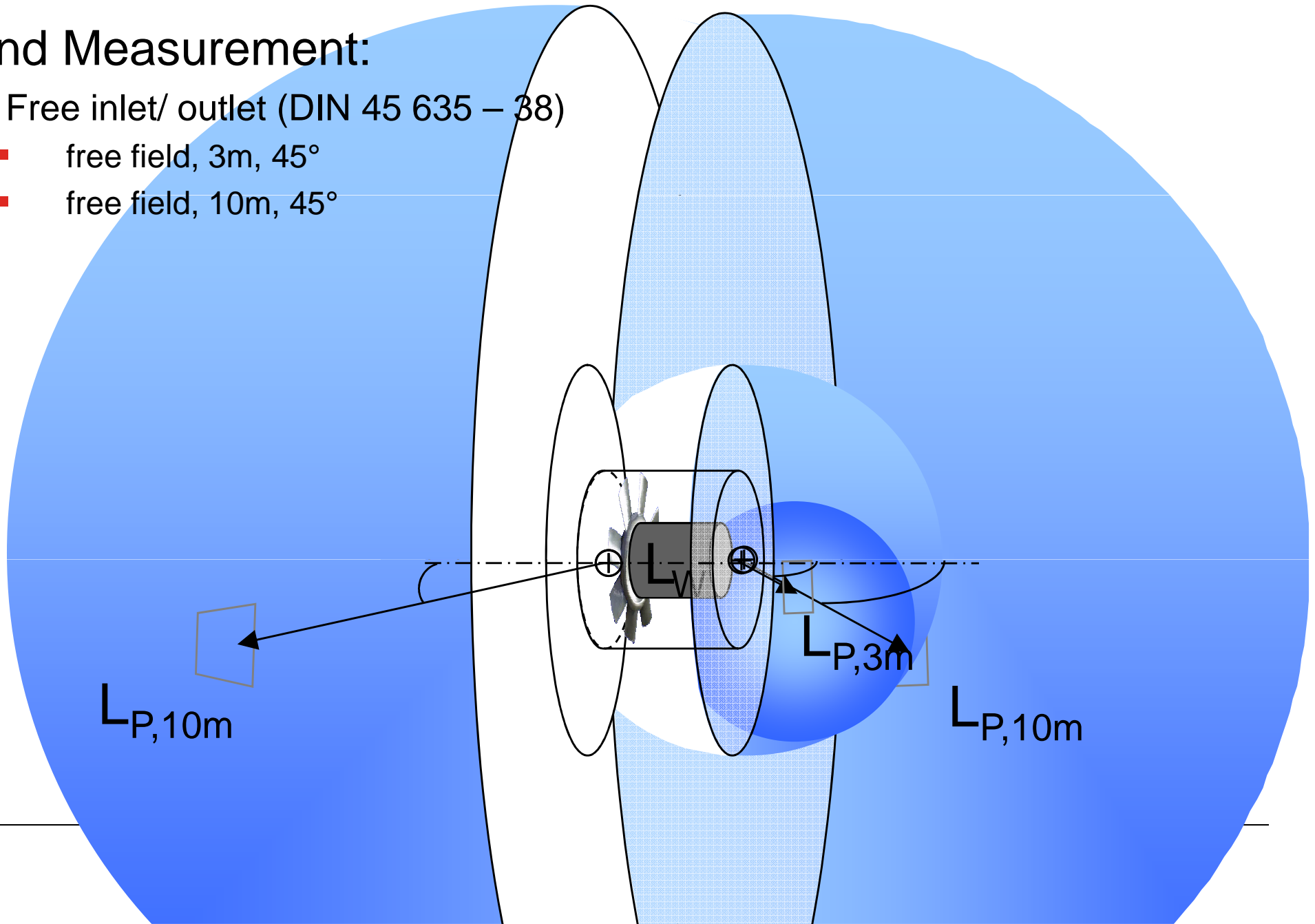
Sound Measurement:

- Free inlet/ outlet (DIN 45 635 – 38)
- free field, 3m, 45°



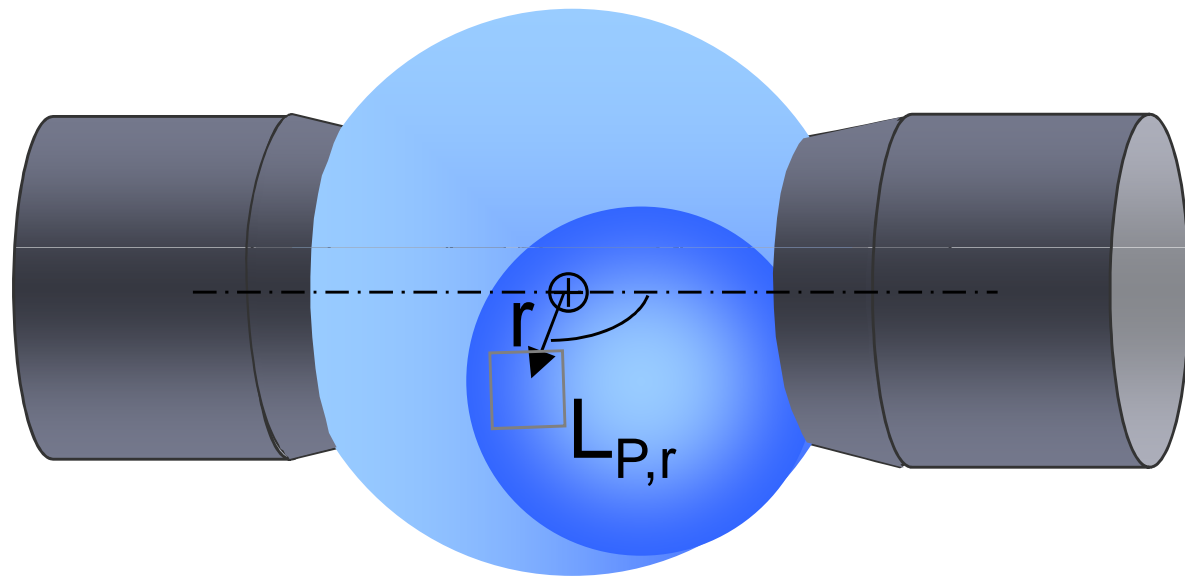
Sound Measurement:

- Free inlet/ outlet (DIN 45 635 – 38)
 - free field, 3m, 45°
 - free field, 10m, 45°



Sound Measurement:

- Free inlet/ outlet (DIN 45 635 – 38)
 - free field, 3m, 45°
- Casing break-out Noise
 - free field, 1m, 90°



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Corrections of Noise Level:

- Batteries of Parallel Jet Fans

No. of Parallel Fans	$\Delta L_{P, \text{install}}$ [dB]
2	+3
3	+5
4	+6

Corrections of Noise Level:

- from “free field (3m, 45°) “ to “tunnel“

Tunnel Wall Type	$\Delta L_{P, \text{ tunnel}} \text{ [dB]}$
Tiled Walls	Approx.. +6
Concrete Walls	Approx. +2.5
Blasted Rock	± 0

Corrections of Noise Level:

$$L_{P,\text{free field, 3m, 45}^\circ} = L_{P,\text{tunnel}} - \Delta L_{P,\text{install}} - \Delta L_{P,\text{tunnel}}$$

Sample:

- $L_{P,\text{free field, 3m, 45}^\circ} = 85\text{dB(A)} - 6\text{dB} - 2.5\text{dB}$

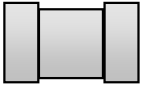




$$L_{P,\text{free field, 3m, 45}^\circ} \sim \underline{76.5 \text{ dB(A)}}$$


→ used value for jet fan selection

Corrections of Noise Level:

- Protection Grills = Bird Screens
 - approx. + 2dB(A)
(tip: place grill in silencer at 50% of length)
 - approx. 2 % losses for each grill
on top of shaft power

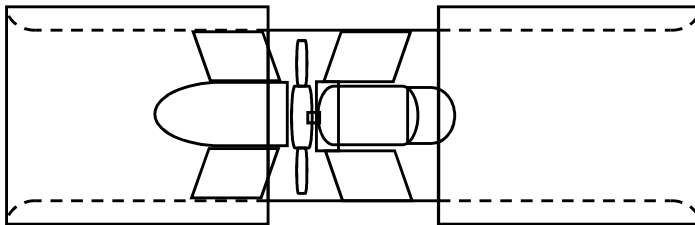
Attenuation of Noise Level:

Length of Silencers	$\Delta L_{P, \text{silencer}}$ [dB]
0.5D 	approx. -2.0
1D 	approx. -6.0
1.5D 	approx. -8.5
2D 	approx. -11.0
3D 	approx. -16.0

 longer silencers not really reasonable

■ Silencers Types:

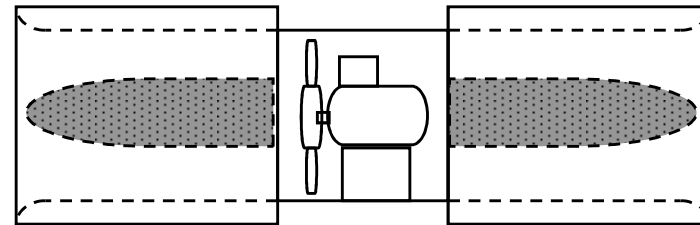
WITT&SOHN
(without pod)



Advantages WITT&SOHN:

- No additional losses
- Low Sound pressure level due to sophisticated design
- High efficiency fan

Competitors use
(with pod)



Disadvantages with pod:

- Fan efficiency decreased
- Costs increased due to additional pod

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Axial Fans

Attenuation of Noise Level:

- by round silencers (see jet fans above)
- by split silencers:

$$- \Delta p_{\text{loss}} \sim \frac{\text{width}_{\text{silencer module}}}{\text{width}_{\text{opening}}} \sim 100 - 200 \text{ Pa}$$

- max. air speed inside silencer:

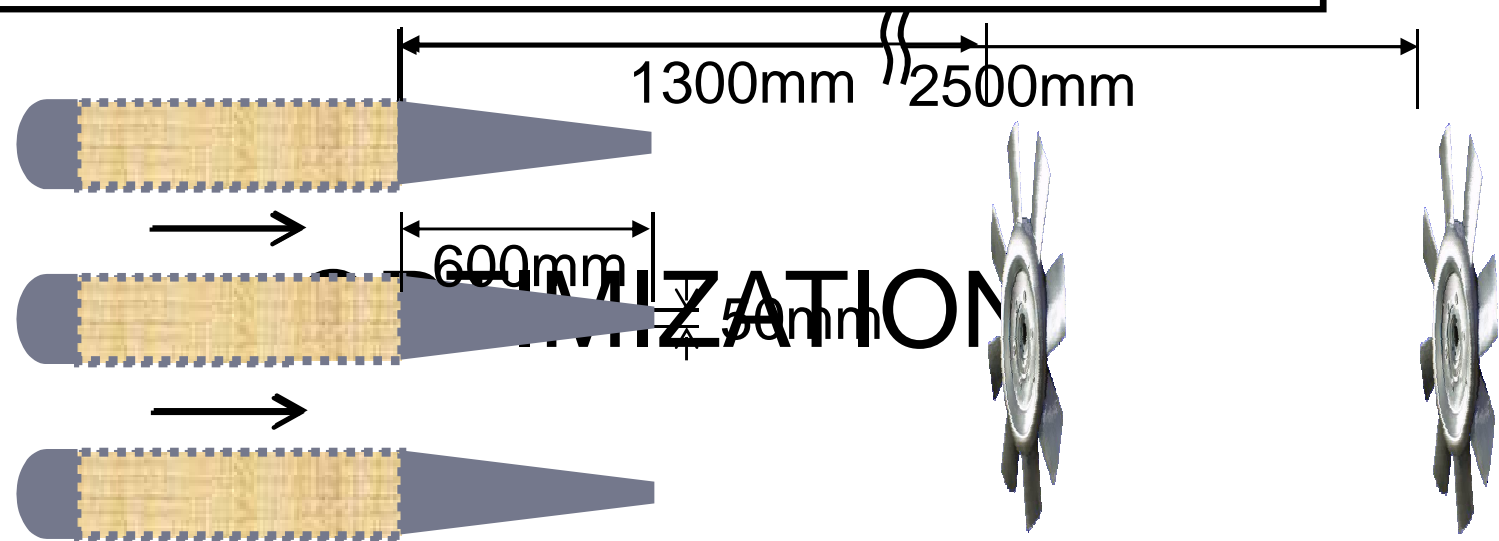
$$c_{\text{air}} \leq 15 \text{ m/s}$$

Axial Fans

Attenuation of Noise Level:

- by split silencers:
 - min. distances before impeller:

$$S_{\text{safety}} \geq 12 \cdot \text{width}_{\text{silencer module}} + 100\text{mm}$$

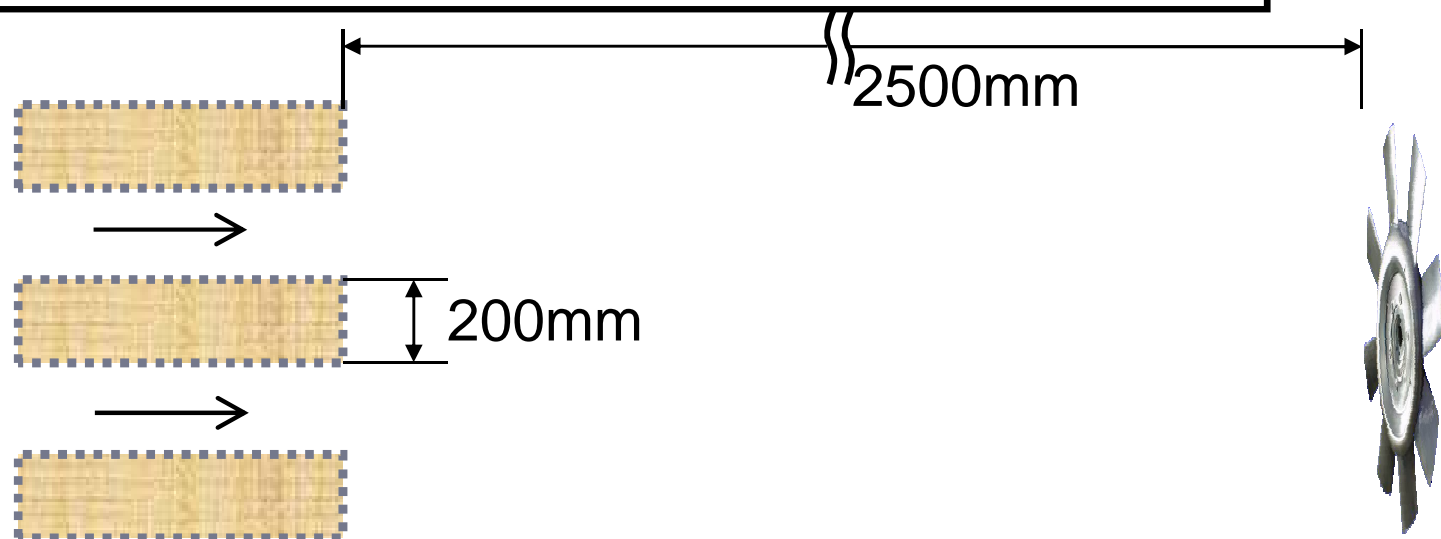


➔ otherwise stall operation likely!

Attenuation of Noise Level:

- by split silencers:
 - min. distances before impeller:

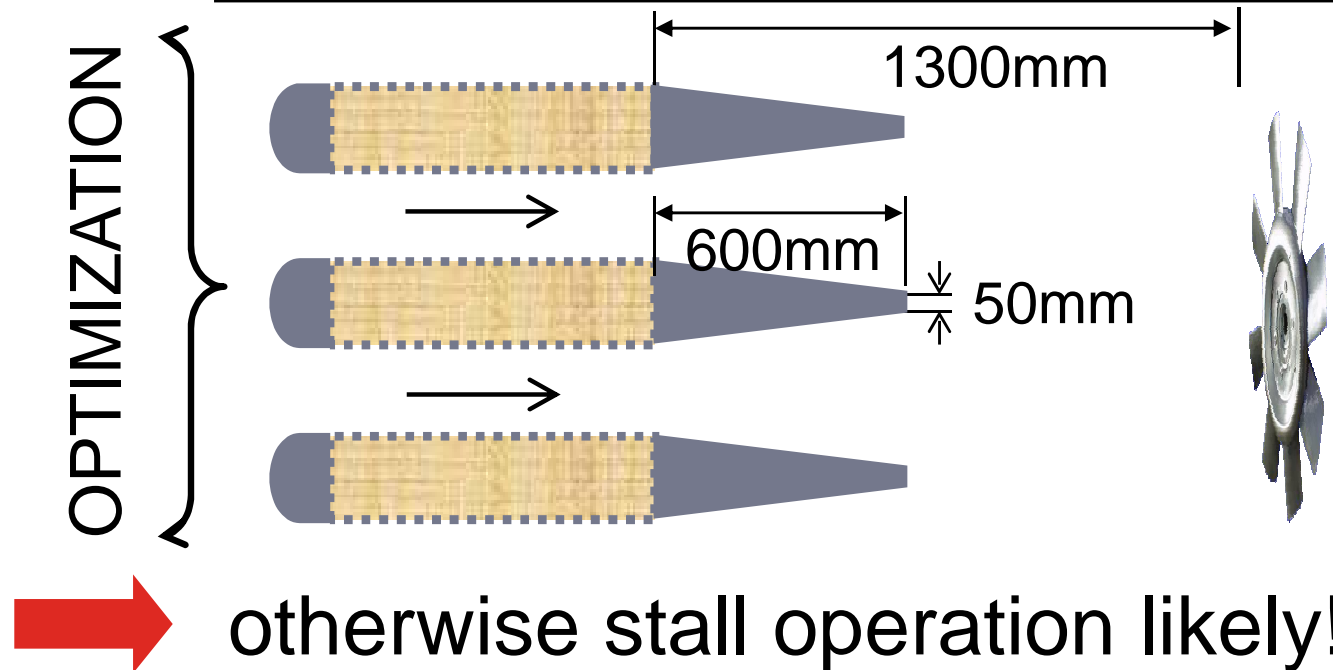
$$S_{\text{safety}} \geq 12 \cdot \text{width}_{\text{silencer module}} + 100\text{mm}$$



Attenuation of Noise Level:

- by split silencers:
 - min. distances before impeller:

$$S_{\text{safety}} \geq 12 \cdot \text{width}_{\text{silencer module}} + 100\text{mm}$$



Summary

- The sound power level of a fan is mainly determined by its volume flow rate / pressure characteristic
- Sound pressure can be measured, sound power is calculated
- Influence of number of jet fans installed in tunnel on sound pressure level
- Influence of tunnel wall types on sound pressure level
- How much attenuation you can achieve with increasing length of silencers for jet fans
- Disadvantages of silencers with pods for jet fans
- Silencers for axial fans