

# SUPPORTING MATERIAL TO

## “Attenuation of sound by polyurethane mats in ventilation ducts – a study with a laboratory model setup”

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In all tables, the  $f$  symbol denotes the center frequency of the 1/3 octave-wide band.

**Table S1.**

Suppression of the 72 dB SPL white noise by the 2 cm-thick PUR mat on the speaker grille

| $f / \text{Hz}$ | $\Delta L_f / \text{dB}$ |                     |                      |                      |                      |
|-----------------|--------------------------|---------------------|----------------------|----------------------|----------------------|
|                 | $l = 25 \text{ cm}$      | $l = 50 \text{ cm}$ | $l = 100 \text{ cm}$ | $l = 150 \text{ cm}$ | $l = 200 \text{ cm}$ |
| 100             | 0.20                     | 1.20                | 0.90                 | 0.60                 | 0.50                 |
| 125             | 1.00                     | 1.80                | 1.30                 | 1.80                 | 0.20                 |
| 160             | 2.50                     | 2.60                | 2.50                 | 2.50                 | 1.80                 |
| 200             | 2.70                     | 3.40                | 2.90                 | 2.90                 | 1.80                 |
| 250             | 2.40                     | 2.60                | 2.40                 | 2.40                 | 1.90                 |
| 315             | 0.00                     | 0.50                | 0.70                 | 0.50                 | 1.20                 |
| 400             | -0.80                    | -0.90               | -0.50                | -0.50                | -1.30                |
| 500             | -0.90                    | -1.00               | -1.40                | -1.30                | -1.50                |
| 630             | -1.60                    | -1.00               | -1.90                | -0.90                | -0.5                 |
| 800             | -1.30                    | -0.60               | -1.40                | -1.00                | -1.80                |
| 1000            | 1.60                     | 1.20                | 0.80                 | 1.00                 | 1.10                 |
| 1250            | 5.20                     | 4.80                | 4.10                 | 3.70                 | 2.90                 |
| 1600            | 9.70                     | 10.10               | 9.60                 | 9.10                 | 8.80                 |
| 2000            | 12.10                    | 12.10               | 12.50                | 12.80                | 12.70                |
| 2500            | 14.70                    | 14.40               | 14.80                | 14.70                | 14.80                |
| 3200            | 14.90                    | 14.60               | 15.20                | 14.80                | 14.80                |
| 4000            | 15.00                    | 15.40               | 15.10                | 14.50                | 15.10                |
| 5000            | 14.20                    | 14.40               | 15.20                | 15.10                | 15.30                |
| 6300            | 15.00                    | 15.20               | 15.00                | 14.70                | 15.00                |
| 8000            | 14.30                    | 14.40               | 14.70                | 14.60                | 14.60                |
| 10000           | 16.10                    | 17.00               | 16.70                | 16.50                | 17.30                |
| 12500           | 20.00                    | 20.40               | 20.10                | 20.30                | 20.70                |
| 16000           | 20.50                    | 21.80               | 20.10                | 20.30                | 21.20                |
| 20000           | 22.20                    | 23.70               | 21.60                | 20.50                | 20.20                |

**Table S2.**

Suppression of the 72 dB SPL white noise by the 4 cm-thick PUR mat on the speaker grille.

| $f / \text{Hz}$ | $\Delta L_f / \text{dB}$ |                     |                      |                      |                      |
|-----------------|--------------------------|---------------------|----------------------|----------------------|----------------------|
|                 | $l = 25 \text{ cm}$      | $l = 50 \text{ cm}$ | $l = 100 \text{ cm}$ | $l = 150 \text{ cm}$ | $l = 200 \text{ cm}$ |
| 100             | 2.40                     | 0.60                | 0.60                 | 0.80                 | 1.20                 |
| 125             | 3.60                     | 1.90                | 1.90                 | 2.20                 | 1.30                 |
| 160             | 3.80                     | 2.70                | 2.70                 | 2.60                 | 2.10                 |
| 200             | 4.50                     | 3.00                | 3.00                 | 2.40                 | 2.10                 |
| 250             | 4.00                     | 3.80                | 3.80                 | 1.50                 | 1.50                 |
| 315             | 0.00                     | 2.70                | 2.70                 | -1.40                | 0.20                 |
| 400             | 0.00                     | -0.80               | -0.80                | -1.10                | -1.50                |
| 500             | 1.20                     | -0.30               | -0.30                | 0.10                 | -0.50                |
| 630             | 1.00                     | 0.90                | 0.90                 | 1.20                 | 2.30                 |
| 800             | 4.40                     | 3.80                | 3.80                 | 2.10                 | 3.90                 |
| 1000            | 7.30                     | 7.10                | 7.10                 | 4.10                 | 6.80                 |
| 1250            | 10.80                    | 12.10               | 12.10                | 9.50                 | 9.30                 |
| 1600            | 15.60                    | 14.50               | 14.50                | 16.20                | 14.70                |
| 2000            | 19.90                    | 20.60               | 20.60                | 20.40                | 21.20                |
| 2500            | 22.90                    | 23.80               | 23.80                | 22.00                | 24.80                |
| 3200            | 23.90                    | 25.30               | 25.30                | 24.10                | 24.10                |
| 4000            | 25.70                    | 25.20               | 25.20                | 24.10                | 25.50                |
| 5000            | 27.40                    | 27.60               | 27.60                | 27.60                | 27.80                |
| 6300            | 32.50                    | 30.90               | 30.90                | 28.50                | 29.80                |
| 8000            | 32.60                    | 33.40               | 33.40                | 33.00                | 32.10                |
| 10000           | 35.60                    | 36.00               | 36.00                | 35.90                | 35.80                |
| 12500           | 41.80                    | 43.30               | 43.30                | 42.50                | 42.40                |
| 16000           | 44.90                    | 45.10               | 45.10                | 43.60                | 42.20                |
| 20000           | 40.60                    | 29.50               | 29.50                | 26.20                | 23.00                |

**Table S3.**

The sound attenuation coefficient of the 4 cm-thick PUR mat

| $f / \text{Hz}$ | $\alpha / \text{cm}^{-1}$ |
|-----------------|---------------------------|
| 1000            | 0.073                     |
| 1250            | 0.324                     |
| 1600            | 0.625                     |
| 2000            | 0.885                     |
| 2500            | 1.133                     |
| 3150            | 1.168                     |
| 4000            | 1.234                     |
| 5000            | 1.410                     |
| 6300            | 1.630                     |

**Table S4.**

The values of SPL at a distance of 150 cm from the loudspeaker emitting the 72 dB white noise.

| $f$ / Hz | $L_f$ / dB |            |
|----------|------------|------------|
|          | Open field | Model duct |
| 100      | 43.95      | 70.76      |
| 125      | 51.86      | 70.02      |
| 160      | 51.19      | 69.02      |
| 200      | 51.48      | 73.82      |
| 250      | 48.32      | 70.44      |
| 315      | 54.17      | 74.45      |
| 400      | 53.30      | 72.99      |
| 500      | 55.64      | 73.53      |
| 630      | 55.27      | 73.63      |
| 800      | 57.96      | 73.10      |
| 1000     | 54.83      | 72.42      |
| 1250     | 55.32      | 76.66      |
| 1600     | 55.39      | 79.14      |
| 2000     | 58.89      | 79.59      |
| 2500     | 61.84      | 79.74      |
| 3200     | 61.02      | 79.73      |
| 4000     | 58.06      | 80.68      |
| 5000     | 61.31      | 80.87      |
| 6300     | 60.44      | 75.61      |
| 8000     | 61.93      | 75.25      |
| 10000    | 62.12      | 75.66      |
| 12500    | 62.25      | 78.92      |
| 16000    | 59.99      | 69.17      |
| 20000    | 36.76      | 42.77      |

**Table S5.**

The values of SPL at the three spots at the end of the model duct.

| $f/\text{Hz}$ | $L_f/\text{dB}$ |               |                |
|---------------|-----------------|---------------|----------------|
|               | Center          | Corner inside | Corner outside |
| 63            | 57.92           | 57.86         | 53.44          |
| 80            | 60.75           | 59.96         | 56.58          |
| 100           | 71.80           | 69.89         | 61.64          |
| 125           | 70.34           | 68.66         | 60.39          |
| 160           | 69.50           | 67.92         | 61.86          |
| 200           | 74.08           | 71.79         | 62.05          |
| 250           | 70.48           | 68.13         | 57.75          |
| 315           | 75.90           | 73.63         | 64.54          |
| 400           | 72.95           | 70.05         | 64.27          |
| 500           | 72.87           | 72.83         | 63.02          |
| 630           | 73.95           | 73.75         | 61.02          |
| 800           | 72.74           | 69.65         | 61.52          |
| 1000          | 71.60           | 65.30         | 59.97          |
| 1250          | 76.07           | 72.44         | 63.44          |
| 1600          | 79.66           | 74.69         | 61.25          |
| 2000          | 80.79           | 74.22         | 64.17          |
| 2500          | 80.29           | 77.38         | 63.07          |
| 3150          | 81.97           | 68.54         | 62.04          |
| 4000          | 82.98           | 75.19         | 61.72          |
| 5000          | 80.86           | 76.18         | 64.90          |
| 6300          | 79.57           | 75.78         | 62.72          |
| 8000          | 76.86           | 75.28         | 60.03          |
| 10000         | 76.79           | 74.29         | 54.67          |
| 12500         | 80.01           | 68.62         | 55.96          |
| 16000         | 70.40           | 69.48         | 49.46          |
| 20000         | 44.00           | 43.29         | 24.82          |

**Table S6.**

The SPL values at the end of the model duct divided by the 4 cm-thick PUR mat at the three distances from the loudspeaker which emitted the 72 dB white noise.

| $f / \text{Hz}$ | $L_f / \text{dB}$   |                     |                      |
|-----------------|---------------------|---------------------|----------------------|
|                 | $d = 38 \text{ cm}$ | $d = 75 \text{ cm}$ | $d = 112 \text{ cm}$ |
| 63              | 55.77               | 55.67               | 56.29                |
| 80              | 58.63               | 58.81               | 59.31                |
| 100             | 62.53               | 68.79               | 63.08                |
| 125             | 63.01               | 69.54               | 62.40                |
| 160             | 66.59               | 63.47               | 66.92                |
| 200             | 68.25               | 60.38               | 68.04                |
| 250             | 63.82               | 61.02               | 64.35                |
| 315             | 63.55               | 71.54               | 65.77                |
| 400             | 63.29               | 62.35               | 64.63                |
| 500             | 67.42               | 67.83               | 64.62                |
| 630             | 65.16               | 63.17               | 66.49                |
| 800             | 61.21               | 65.43               | 62.55                |
| 1000            | 63.16               | 62.57               | 63.07                |
| 1250            | 67.63               | 68.76               | 67.67                |
| 1600            | 70.92               | 70.15               | 70.27                |
| 2000            | 72.24               | 71.39               | 71.51                |
| 2500            | 70.00               | 71.20               | 70.27                |
| 3150            | 68.02               | 69.05               | 68.52                |
| 4000            | 68.60               | 69.66               | 69.40                |
| 5000            | 65.29               | 66.93               | 65.47                |
| 6300            | 62.30               | 66.01               | 62.63                |
| 8000            | 58.84               | 59.05               | 59.23                |
| 10000           | 57.79               | 54.45               | 59.38                |
| 12500           | 58.93               | 56.61               | 60.00                |
| 16000           | 47.88               | 49.30               | 48.59                |
| 20000           | 20.70               | 22.47               | 20.93                |

**Table S7.**

Suppression of sound by the 4 cm-thick PUR mat mounted on the speaker grille and fitted in the middle of the model duct perpendicularly to its longitudinal axis.

| $f / \text{Hz}$ | $\Delta L_f / \text{dB}$ |            |
|-----------------|--------------------------|------------|
|                 | Speaker grille           | Model duct |
| 100             | 1.20                     | 4.49       |
| 125             | 2.24                     | 12.35      |
| 160             | 2.80                     | 13.87      |
| 200             | 3.08                     | 6.43       |
| 250             | 3.08                     | 3.87       |
| 315             | 1.14                     | 8.19       |
| 400             | -0.79                    | 14.32      |
| 500             | 0.08                     | 4.95       |
| 630             | 1.29                     | 12.27      |
| 800             | 3.70                     | 10.33      |
| 1000            | 6.63                     | 12.88      |
| 1250            | 10.92                    | 11.82      |
| 1600            | 15.14                    | 12.21      |
| 2000            | 20.56                    | 13.24      |
| 2500            | 23.57                    | 17.25      |
| 3200            | 24.59                    | 16.04      |
| 4000            | 25.18                    | 17.97      |
| 5000            | 27.59                    | 21.21      |
| 6300            | 30.71                    | 14.83      |
| 8000            | 32.93                    | 20.45      |
| 10000           | 35.85                    | 23.35      |
| 12500           | 42.67                    | 24.98      |
| 16000           | 44.32                    | 25.09      |
| 20000           | 34.39                    | 21.92      |

**Table S8.**

Attenuation of the white noise by the 2 cm-thick PUR mat fitted in the middle of the model duct perpendicularly to its longitudinal axis.

White noise SPLs 72 and 60 dB; n/i – not insulated loudspeaker, i – insulated loudspeaker

| $f / \text{Hz}$ | $\Delta L_f / \text{dB}$ |          |           |          |
|-----------------|--------------------------|----------|-----------|----------|
|                 | 72dB, n/i                | 72 dB, i | 60db, n/i | 60 dB, i |
| 80              | 0.64                     | −1.46    | 0.40      | −1.62    |
| 100             | 1.29                     | 1.45     | 1.09      | 1.51     |
| 125             | 1.73                     | −0.12    | 1.69      | 0.16     |
| 160             | 11.22                    | 9.59     | 11.81     | 10.10    |
| 200             | 6.24                     | 3.61     | 5.86      | 3.14     |
| 250             | 2.11                     | 2.68     | 2.50      | 2.89     |
| 315             | 6.91                     | 7.12     | 6.96      | 7.13     |
| 400             | 5.16                     | 4.67     | 4.94      | 3.99     |
| 500             | 4.92                     | 5.57     | 4.97      | 5.73     |
| 630             | 5.33                     | 5.57     | 5.14      | 5.38     |
| 800             | 4.69                     | 6.28     | 4.78      | 6.09     |
| 1000            | 1.25                     | 5.10     | 1.46      | 5.69     |
| 1250            | 1.38                     | 5.56     | 2.16      | 6.79     |
| 1600            | 0.94                     | 5.06     | 0.72      | 5.53     |
| 2000            | 0.71                     | 4.45     | 0.66      | 4.16     |
| 2500            | 4.16                     | 6.40     | 3.75      | 6.42     |
| 3150            | 2.87                     | 3.42     | 2.45      | 3.14     |
| 4000            | 9.18                     | 9.37     | 8.72      | 8.97     |
| 5000            | 15.04                    | 15.20    | 14.65     | 14.76    |
| 6300            | 15.91                    | 15.92    | 15.72     | 15.74    |
| 8000            | 17.14                    | 17.21    | 17.20     | 16.98    |
| 10000           | 18.69                    | 18.67    | 18.75     | 18.81    |
| 12500           | 21.70                    | 21.79    | 21.57     | 21.75    |
| 16000           | 26.27                    | 26.66    | 23.36     | 23.61    |
| 20000           | 12.85                    | 12.90    | 3.44      | 3.44     |

**Table S9.**

Attenuation of the 72 dB white noise by the 2 cm-thick PUT mat in the model ventilation duct

| $f$ / Hz | $\Delta L_f$ / dB  |                            |                          |                    |                            |                          |
|----------|--------------------|----------------------------|--------------------------|--------------------|----------------------------|--------------------------|
|          | Walls <sup>1</sup> | Perpendicular <sup>1</sup> | Walls+Perp. <sup>1</sup> | Walls <sup>2</sup> | Perpendicular <sup>2</sup> | Walls+Perp. <sup>2</sup> |
| 100      | 1.00               | 0.90                       | 2.10                     | 0.00               | 1.50                       | 0.80                     |
| 125      | 2.30               | 0.10                       | 2.60                     | 0.40               | 1.90                       | 2.90                     |
| 160      | -4.30              | -0.40                      | 0.10                     | 3.70               | 4.60                       | 6.40                     |
| 200      | 2.00               | 4.60                       | 5.80                     | -0.30              | 2.80                       | 0.10                     |
| 250      | -0.80              | 2.70                       | 0.90                     | 4.10               | 1.70                       | 5.10                     |
| 315      | 1.90               | 0.50                       | 4.70                     | 2.60               | 2.10                       | 6.20                     |
| 400      | 2.40               | 3.00                       | 5.10                     | 4.80               | 5.40                       | 6.20                     |
| 500      | 5.20               | 2.40                       | 7.40                     | 6.20               | 1.50                       | 8.90                     |
| 630      | 8.90               | 4.30                       | 11.30                    | 9.40               | 4.30                       | 11.70                    |
| 800      | 12.70              | 3.10                       | 14.90                    | 13.90              | 3.30                       | 16.30                    |
| 1000     | 22.90              | 3.90                       | 22.40                    | 25.40              | 3.50                       | 26.30                    |
| 1250     | 32.80              | 3.40                       | 31.00                    | 39.30              | 2.60                       | 36.90                    |
| 1600     | 39.90              | 3.20                       | 38.00                    | 40.80              | 2.50                       | 41.20                    |
| 2000     | 33.00              | 4.20                       | 38.80                    | 33.80              | 3.20                       | 35.90                    |
| 2500     | 22.30              | 5.60                       | 27.20                    | 23.20              | 4.30                       | 25.50                    |
| 3200     | 23.30              | 6.60                       | 29.70                    | 24.00              | 5.40                       | 29.20                    |
| 4000     | 23.00              | 8.50                       | 29.20                    | 18.50              | 5.50                       | 25.60                    |
| 5000     | 16.90              | 7.70                       | 24.50                    | 11.00              | 9.20                       | 21.20                    |
| 6300     | 11.40              | 11.20                      | 22.60                    | 7.00               | 12.40                      | 20.40                    |
| 8000     | 6.30               | 14.20                      | 19.20                    | 5.30               | 13.80                      | 18.10                    |
| 10000    | 4.20               | 16.60                      | 20.20                    | 5.60               | 14.90                      | 20.20                    |
| 12500    | 11.10              | 20.80                      | 30.80                    | 10.60              | 20.10                      | 31.00                    |
| 16000    | 11.80              | 18.10                      | 36.90                    | 10.40              | 20.40                      | 36.90                    |
| 20000    | 12.60              | 17.90                      | 31.80                    | 10.70              | 16.90                      | 30.40                    |

<sup>1</sup> both tube ends open<sup>2</sup> both ends acoustically insulated

**Table S10.**

Attenuation of the 72 dB white noise by the 2 cm-thick PUR mat in the model ventilation duct

| $f / \text{Hz}$ | $\Delta L_f / \text{dB}$ |               |             |       |               |             |
|-----------------|--------------------------|---------------|-------------|-------|---------------|-------------|
|                 | Walls                    | Perpendicular | Walls+Perp. | Walls | Perpendicular | Walls+Perp. |
| 100             | 0.40                     | 0.70          | 1.90        | 1.10  | 0.50          | 1.60        |
| 125             | 1.70                     | 0.40          | 2.90        | 0.60  | 1.40          | 2.70        |
| 160             | -3.50                    | 0.50          | -1.40       | 3.50  | 2.50          | 5.00        |
| 200             | 1.70                     | 3.40          | 3.70        | 0.70  | 1.30          | 1.70        |
| 250             | -0.40                    | 1.30          | 1.80        | 4.40  | 0.50          | 5.60        |
| 315             | 2.60                     | 0.70          | 4.30        | 3.20  | 1.40          | 4.30        |
| 400             | 3.10                     | 2.00          | 4.60        | 5.60  | 3.00          | 7.30        |
| 500             | 6.60                     | 1.60          | 9.30        | 7.40  | 1.00          | 8.70        |
| 630             | 10.30                    | 2.30          | 12.70       | 10.70 | 2.40          | 11.90       |
| 800             | 14.10                    | 2.00          | 15.80       | 14.70 | 2.20          | 15.70       |
| 1000            | 23.10                    | 1.80          | 22.00       | 23.80 | 2.10          | 24.80       |
| 1250            | 30.30                    | 2.60          | 29.80       | 32.20 | 2.10          | 34.80       |
| 1600            | 39.40                    | 1.90          | 43.20       | 40.40 | 1.30          | 40.00       |
| 2000            | 39.10                    | 2.20          | 40.90       | 38.50 | 1.00          | 41.30       |
| 2500            | 27.10                    | 2.80          | 28.80       | 21.70 | 1.00          | 26.00       |
| 3200            | 17.10                    | 2.70          | 20.70       | 15.10 | -0.40         | 19.70       |
| 4000            | 15.20                    | 4.40          | 19.10       | 9.10  | 0.70          | 13.00       |
| 5000            | 9.80                     | 3.80          | 13.70       | 7.60  | 3.70          | 11.10       |
| 6300            | 8.30                     | 5.10          | 12.90       | 4.50  | 5.30          | 7.10        |
| 8000            | 3.60                     | 6.70          | 8.10        | 2.20  | 7.70          | 6.20        |
| 10000           | 6.90                     | 6.30          | 11.40       | 6.00  | 6.80          | 11.70       |
| 12500           | 14.10                    | 5.90          | 20.90       | 15.70 | 5.00          | 21.80       |
| 16000           | 12.80                    | 6.70          | 19.50       | 12.30 | 5.90          | 19.10       |
| 20000           | 10.80                    | 6.70          | 16.90       | 7.90  | 5.70          | 14.90       |

<sup>1</sup> both tube ends open<sup>2</sup> both ends acoustically insulated