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Supplemental Information for:

Fine and Ultrafine Particle Removal Efficiency of New Residential HVAC Filters

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A.1. Apartment unit characteristics

Figure A.1 shows the unoccupied apartment unit used for testing in this work, including a floor plan.

Figure A.1. The unoccupied apartment unit used in this work

Figure A.2 shows the experimental setup, including a section view and plan view of the instruments, AHU, and ductwork, and a photo of the instrument setup.

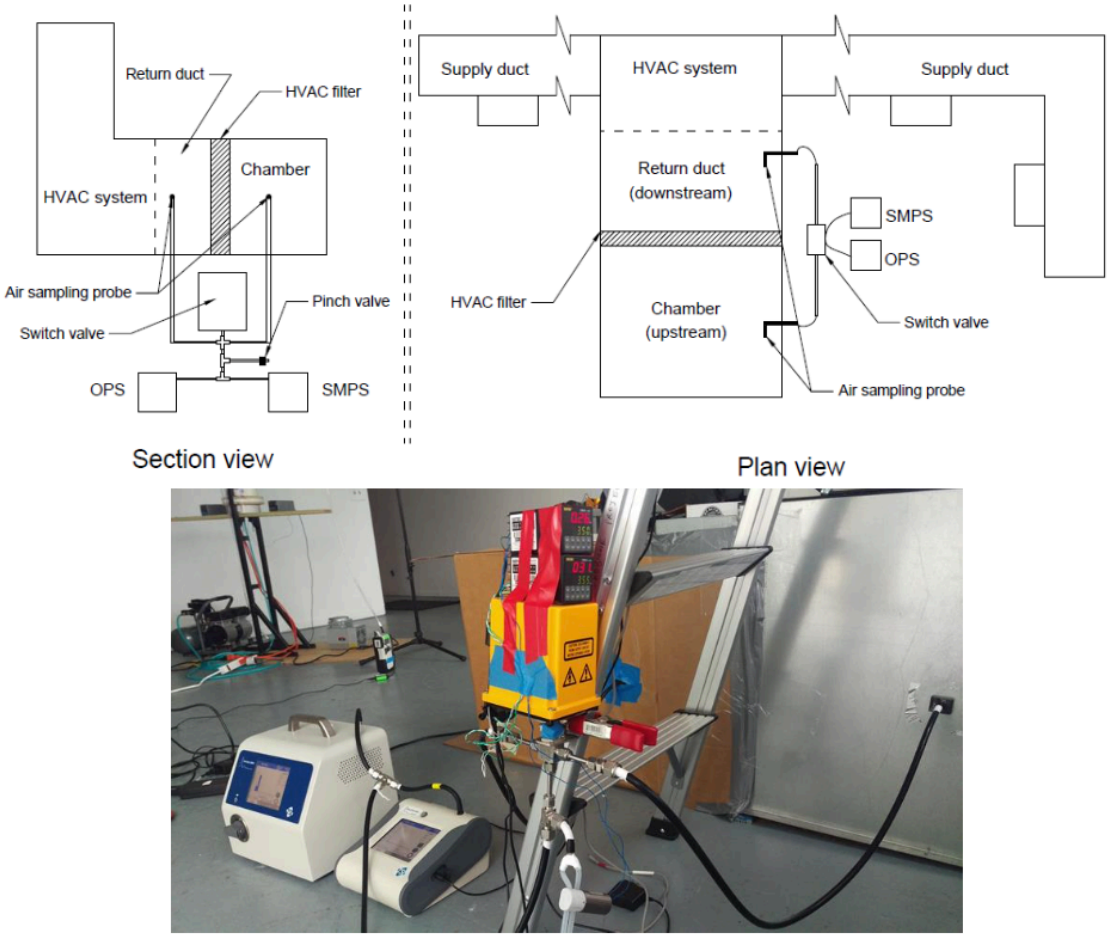

Figure A.2 Section view, plan view, and photo of the experimental setup (not to scale)

A.2. Upstream particle size distribution of NaCl and incense particles together and independently

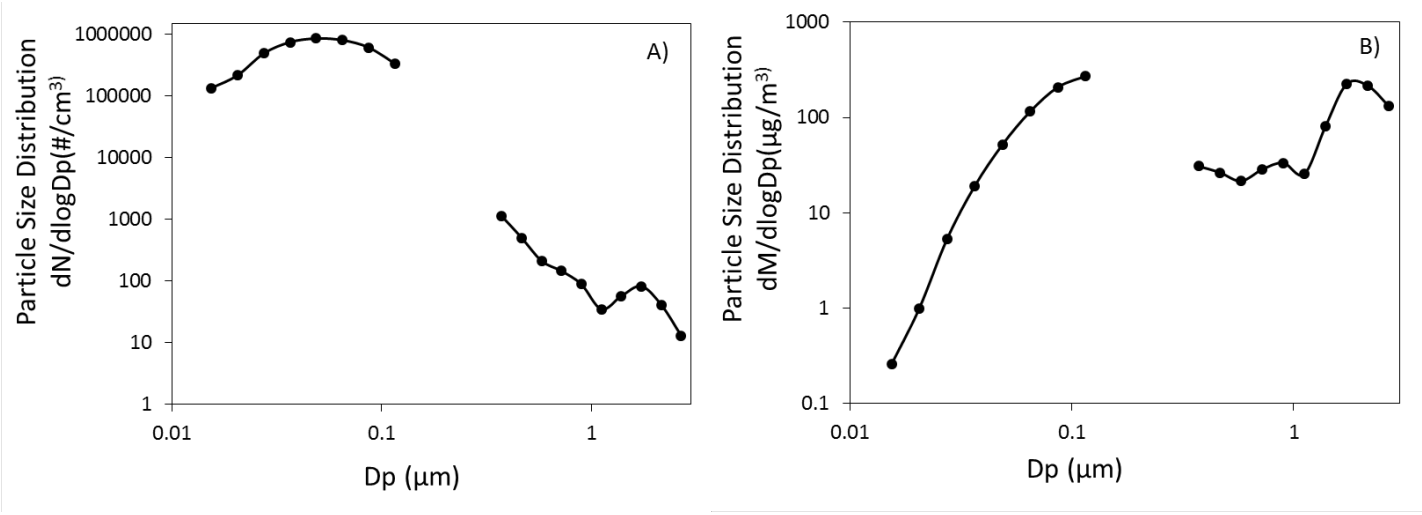

Figure A.3. Typical upstream particle size distribution of NaCl and incense particles injected simultaneously: a) number distributions and b) estimated mass distributions.

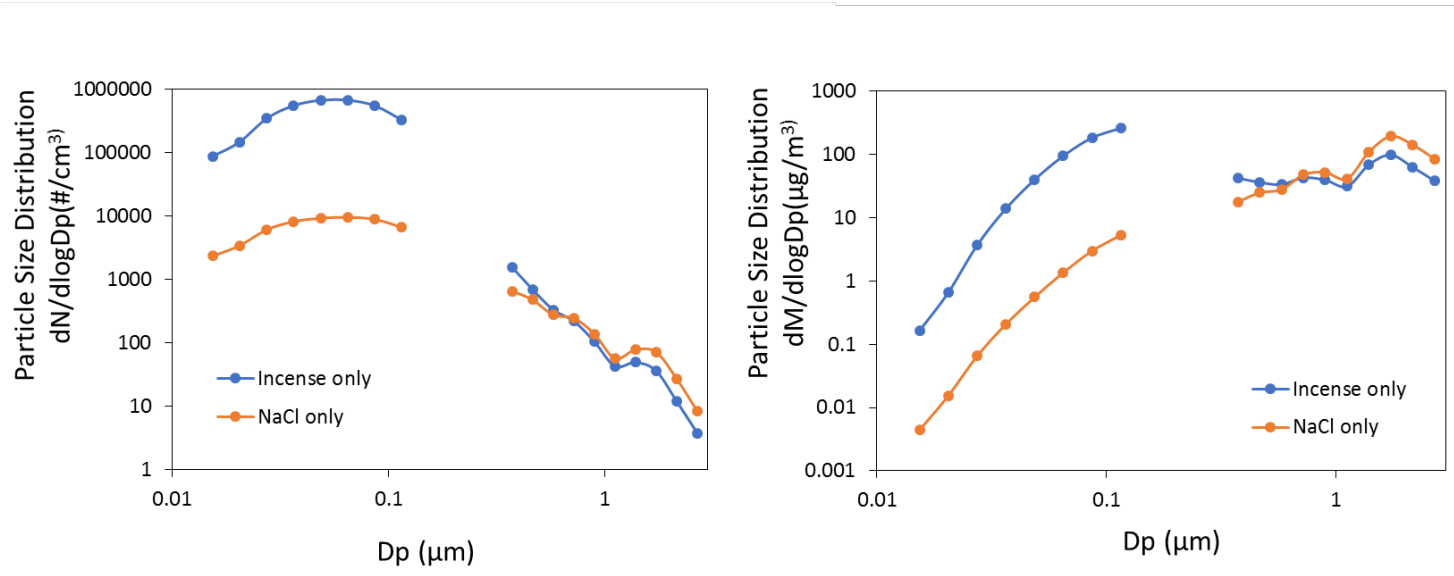

Figure A.4. Typical upstream particle size distribution of NaCl and incense particles injected separately: a) number distributions and b) estimated mass distributions.

A.3. Filter characteristics

Table A.1. Characteristics of 50 commercially available residential HVAC filters tested new in the unoccupied apartment unit

Filter No.	Manufacturer	Model	Type	Rated efficiency	Depth, cm (in)	Filter ΔP, Pa (in. w.c.)	Airflow rate, m^3/hr (cfm)	Average Temperature during test using OPS (°C)
1	FLANDERS	EZ-Flow II	Non-Electrostatic	MERV 1-4	2.5 (1)	11.4 (0.046)	1180 (694)	30.8
2	AIRFILTERBUY	AFB16x25x1M6	Non-Electrostatic	MERV 6	2.5 (1)	48.4 (0.195)	1108 (652)	32.4
3	AIRFILTERBUY	AFB16x25x2M6	Non-Electrostatic	MERV 6	5.1 (2)	35.9 (0.144)	1137 (670)	32.4
4	TEX-AIR	Air relief minipleat	Electrostatic	MERV 7	2.5 (1)	62 (0.249)	1104 (650)	31.6
5	TEX-AIR	Air relief minipleat	Electrostatic	MERV 7	5.1 (2)	28.8 (0.116)	1139 (671)	32.1
6	TEX-AIR	Air relief minipleat	Electrostatic	MERV 7	10.2 (4)	21.9 (0.088)	1177 (693)	36.3
7	WEB-ECO	Filter Plus	Washable Electrostatic	MERV 8	2.5 (1)	38 (0.153)	1123 (661)	37.2
8	AIRGUARD	DP40-STD1-102	Non-Electrostatic	MERV 8	2.5 (1)	49.9 (0.201)	1100 (648)	36.2
9	AIRGUARD	MX40-STD1-102	Non-Electrostatic	MERV 8	2.5 (1)	60.9 (0.245)	1086 (639)	35.9
10	AIRGUARD	DP40-STD2-202	Non-Electrostatic	MERV 8	5.1 (2)	30.9 (0.124)	1142 (672)	27.5
11	AIRGUARD	MX40-STD2-202	Non-Electrostatic	MERV 8	5.1 (2)	37.9 (0.152)	1139 (670)	40.2
12	AIRGUARD	DP40-STD4-402	Non-Electrostatic	MERV 8	10.2 (4)	23.8 (0.096)	1156 (681)	37.6
13	AIRGUARD	MX40-STD4-402	Non-Electrostatic	MERV 8	10.2 (4)	24.3 (0.098)	1159 (682)	34.8
14	FLANDERS	RE-PLEAT 40 LPD	Non-Electrostatic	MERV 8	5.1 (2)	27.4 (0.11)	1152 (678)	30.1
15	TEX-AIR	Air relief minipleat	Electrostatic	MERV 8	2.5 (1)	43.1 (0.173)	1121 (660)	42.8
16	TEX-AIR	Air relief minipleat	Electrostatic	MERV 8	5.1 (2)	34.2 (0.137)	1138 (670)	35.1

17	TEX-AIR	Air relief minipleat	Electrostatic	MERV 8	10.2 (4)	24.4 (0.098)	1153 (679)	40.6
18	QUALITY FILTERS	Odorban	Electrostatic	MERV 8	5.1 (2)	29.3 (0.118)	1146 (674)	24.9
19	QUALITY FILTERS	Pleated Panel	Electrostatic	MERV 8	5.1 (2)	33.9 (0.136)	1134 (668)	37.7
20	AIRGUARD	PWG-STD1-102	Electrostatic	MERV 11	2.5 (1)	82.9 (0.333)	1111 (654)	25.8
21	AIRGUARD	PWG-STD2-202	Electrostatic	MERV 11	5.1 (2)	40 (0.161)	1128 (664)	28.8
22	AIRGUARD	PWG-STD4-402	Electrostatic	MERV 11	10.2 (4)	37.6 (0.151)	1132 (666)	28.5
23	FLANDERS	Pre-pleat-40	Non-Electrostatic	MERV 11	5.1 (2)	38.5 (0.155)	1129 (665)	30.8
24	TEX-AIR	Air relief minipleat	Electrostatic	MERV 11	2.5 (1)	60.9 (0.245)	1077 (634)	32.8
25	TEX-AIR	Air relief minipleat	Electrostatic	MERV 11	5.1 (2)	38.4 (0.154)	1128 (664)	34.0
26	TEX-AIR	Air relief minipleat	Electrostatic	MERV 11	10.2 (4)	24.9 (0.1)	1149 (677)	35.6
27	QUALITY FILTERS	MQP Pleated Panel	Electrostatic	MERV 11	5.1 (2)	34.1 (0.137)	1135 (668)	32.5
28	AIRGUARD	Dp-13-STD1-102	Non-Electrostatic	MERV 13	2.5 (1)	90.5 (0.364)	1030 (606)	30.9
29	AIRGUARD	DP13-STD2-202	Non-Electrostatic	MERV 13	5.1 (2)	51 (0.205)	1098 (647)	39.6
30	AIRGUARD	DP13-STD4-402	Non-Electrostatic	MERV 13	10.2 (4)	41.3 (0.166)	1136 (669)	21.8
31	FLANDERS	Pre-Pleated 40	Non-Electrostatic	MERV 13	5.1 (2)	41.5 (0.167)	1118 (658)	22.4
32	TEX-AIR	Air relief minipleat	Electrostatic	MERV 13	2.5 (1)	84 (0.338)	1039 (612)	42.2
33	TEX-AIR	Air relief minipleat	Electrostatic	MERV 13	5.1 (2)	49.5 (0.199)	1140 (671)	37.1
34	TEX-AIR	Air relief minipleat	Electrostatic	MERV 13	10.2 (4)	33.1 (0.133)	1130 (665)	28.5
35	QUALITY FILTERS	GQP Pleated Panel	Electrostatic	MERV 13	5.1 (2)	40.6 (0.163)	1119 (659)	25.3
36	HEALTHY SOLUTION CLIMATE	Carbon clean	Electrostatic	MERV 16	12.7 (5)	30.3 (0.122)	1143 (673)	25.4

37	3M	Basic Dust Clean Living	Electrostatic	MPR 300	2.5 (1)	38.8 (0.156)	1119 (659)	28.2
38	3M	Clean Living Dust Reduction	Electrostatic	MPR 300	2.5 (1)	42.4 (0.17)	1111 (654)	26.3
39	3M	Filtrete Clean Living	Electrostatic	MPR 600	2.5 (1)	52.2 (0.21)	1105 (650)	31.3
40	3M	Micro Allergen Defense	Electrostatic	MPR 1000	2.5 (1)	45.9 (0.184)	1100 (648)	33.2
41	3M	Micro Allergen Reduction Filter	Electrostatic	MPR 1000	10.2 (4)	25 (0.1)	1133 (667)	22.2
42	3M	High Performance Allergen Reduction Filter	Electrostatic	MPR 1550	10.2 (4)	33.3 (0.134)	1109 (653)	24.5
43	3M	High Performance Maximum Allergen Reduction Filter	Electrostatic	MPR 1900	2.5 (1)	39.1 (0.157)	1074 (632)	23.5
44	3M	Filtrete Healthy Living	Electrostatic	MPR 2200	2.5 (1)	46.4 (0.186)	1051 (619)	37.2
45	3M	Ultrafine Particle Reduction	Electrostatic	MPR 2800	2.5 (1)	49.6 (0.199)	1143 (673)	20.7
46	RHEEM	Dust & Pollen	Non-Electrostatic	FPR 4	2.5 (1)	35.9 (0.144)	1125 (662)	33.9
47	HONEYWELL	Allergen Plus Air Filter	Electrostatic	FPR 7	2.5 (1)	45.2 (0.182)	1109 (653)	27.0
48	HONEYWELL	Superior Allergen Air Filter	Electrostatic	FPR 9	2.5 (1)	52.7 (0.212)	1096 (645)	43.3
49	HONEYWELL	Elite Allergen Air Filter	Electrostatic	FPR 10	2.5 (1)	49.5 (0.199)	1107 (652)	33.9
50	HONEYWELL	Ultimate Allergen Air Filter	Electrostatic	FPR 10	10.2 (4)	24.4 (0.098)	1155 (680)	34.0

A.4. Particle losses in the HVAC system without a filter

The background particle losses in the HVAC system were measured by conducting size-resolved removal efficiency measurements without a filter installed. Figure A.5 shows the background particle loss in the operating HVAC system without a filter resulting from these tests. Values represent the mean and standard deviations of estimates resulting from three replicate tests without a filter. The mean value of indoor particle loss for each size bin was less than 15% with a standard deviation less than 10%, suggesting the background loss is relatively stable. The relative standard deviation was generally higher for smaller particles, likely due to low counting efficiencies at lower indoor concentrations in those sizes.

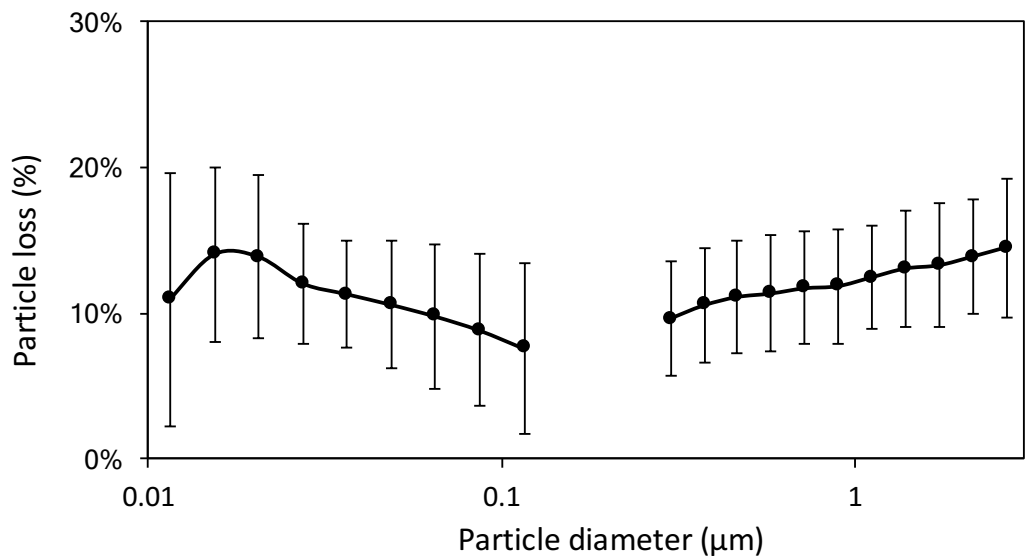

Figure A.5. Particle losses in the test HVAC system measured without a filter during 4 replicate tests

A.5. Repeatability of filter measurements

To test the repeatability of the removal efficiency measurements, two filters were selected at random and tested in triplicate. Relative standard deviations of the means across the triplicate tests ranged from ~12% for particles in the ultrafine size range to ~0% in the fine particle size range (Figure A.6).

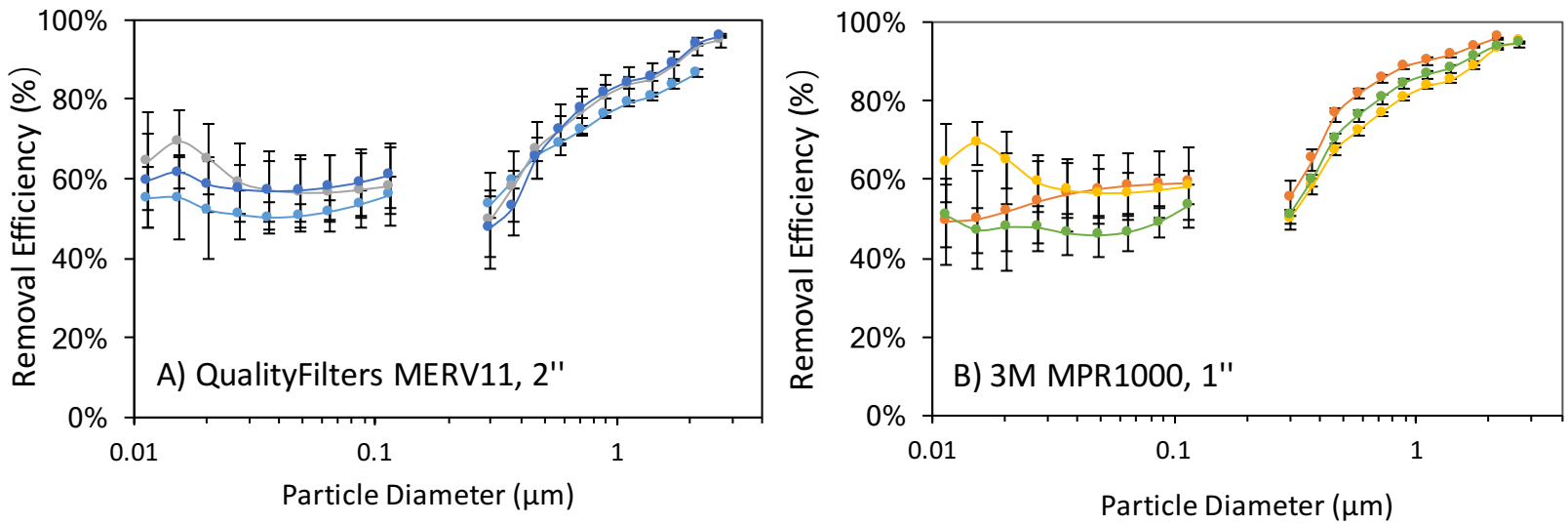

Figure A.6. Results of triplicate filter testing for two randomly selected filters

A.6. Size-resolved removal efficiency results from measurements

Table A.2. Size-resolved removal efficiencies measured for each of the 50 tested HVAC filters

Particle size (µm) → Filter ↓	0.0115	0.0154	0.0205	0.0274	0.0365	0.0487	0.0649	0.0866	0.1155	0.3	0.374	0.465	0.579	0.721	0.897	1.117	1.391	1.732	2.156	2.685
MERV < 4,1" (Flanders)	0.45 (±0.14)	0.54 (±0.09)	0.61 (±0.09)	0.56 (±0.1)	0.49 (±0.09)	0.44 (±0.09)	0.4 (±0.09)	0.38 (±0.09)	0.38 (±0.09)	0.27 (±0.07)	0.24 (±0.07)	0.17 (±0.08)	0.12 (±0.07)	0.08 (±0.05)	0.1 (±0.05)	0.14 (±0.04)	0.16 (±0.05)	0.21 (±0.06)	0.2 (±0.07)	0.15 (±0.13)
MERV 6,1" (AirFilterBuy)	0.52 (±0.1)	0.48 (±0.07)	0.49 (±0.06)	0.51 (±0.05)	0.52 (±0.05)	0.51 (±0.06)	0.47 (±0.06)	0.43 (±0.06)	0.4 (±0.06)	0.47 (±0.04)	0.53 (±0.04)	0.59 (±0.04)	0.65 (±0.04)	0.7 (±0.04)	0.78 (±0.04)	0.82 (±0.04)	0.85 (±0.04)	0.87 (±0.04)	0.89 (±0.04)	0.9 (±0.05)
MERV 6,2" (AirFilterBuy)	0.78 (±0.1)	0.77 (±0.06)	0.74 (±0.06)	0.73 (±0.05)	0.73 (±0.05)	0.71 (±0.05)	0.68 (±0.05)	0.63 (±0.06)	0.59 (±0.07)	0.56 (±0.05)	0.59 (±0.05)	0.63 (±0.05)	0.67 (±0.05)	0.7 (±0.04)	0.76 (±0.04)	0.8 (±0.04)	0.83 (±0.04)	0.86 (±0.04)	0.88 (±0.04)	0.9 (±0.05)
MERV 7,1" (AirRelief Tex-air)	0.38 (±0.1)	0.36 (±0.06)	0.33 (±0.06)	0.3 (±0.05)	0.28 (±0.05)	0.27 (±0.06)	0.25 (±0.06)	0.24 (±0.06)	0.23 (±0.08)	0.17 (±0.04)	0.2 (±0.04)	0.24 (±0.04)	0.3 (±0.04)	0.38 (±0.04)	0.48 (±0.04)	0.55 (±0.04)	0.6 (±0.04)	0.66 (±0.05)	0.71 (±0.04)	0.73 (±0.05)
MERV 7,2" (AirRelief Tex-air)	0.45 (±0.1)	0.44 (±0.07)	0.39 (±0.06)	0.36 (±0.04)	0.35 (±0.04)	0.35 (±0.05)	0.36 (±0.06)	0.35 (±0.07)	0.32 (±0.08)	0.27 (±0.05)	0.29 (±0.05)	0.33 (±0.05)	0.36 (±0.05)	0.41 (±0.05)	0.48 (±0.05)	0.53 (±0.05)	0.57 (±0.05)	0.62 (±0.05)	0.68 (±0.04)	0.72 (±0.05)
MERV 7,4" (AirRelief Tex-air)	0.43 (±0.21)	0.39 (±0.22)	0.32 (±0.23)	0.31 (±0.17)	0.29 (±0.16)	0.28 (±0.17)	0.29 (±0.18)	0.29 (±0.22)	0.32 (±0.25)	0.3 (±0.09)	0.33 (±0.09)	0.38 (±0.1)	0.41 (±0.1)	0.45 (±0.1)	0.5 (±0.09)	0.56 (±0.08)	0.59 (±0.07)	0.65 (±0.06)	0.71 (±0.06)	0.75 (±0.06)
MERV 8,1" (WEB-ECO)	0.43 (±0.12)	0.41 (±0.09)	0.42 (±0.08)	0.44 (±0.05)	0.43 (±0.05)	0.43 (±0.05)	0.42 (±0.06)	0.42 (±0.06)	0.43 (±0.07)	0.26 (±0.04)	0.33 (±0.04)	0.44 (±0.04)	0.47 (±0.04)	0.49 (±0.04)	0.51 (±0.04)	0.53 (±0.04)	0.54 (±0.04)	0.61 (±0.04)	0.71 (±0.04)	0.77 (±0.05)
MERV 8,1" (Airguard)	0.36 (±0.1)	0.42 (±0.07)	0.4 (±0.07)	0.35 (±0.06)	0.28 (±0.05)	0.23 (±0.06)	0.19 (±0.06)	0.15 (±0.06)	0.13 (±0.07)	0.21 (±0.06)	0.17 (±0.05)	0.16 (±0.05)	0.15 (±0.05)	0.2 (±0.05)	0.31 (±0.04)	0.38 (±0.05)	0.45 (±0.05)	0.59 (±0.05)	0.76 (±0.04)	0.82 (±0.05)
MERV 8,1" (Airguard)	0.38 (±0.1)	0.33 (±0.06)	0.25 (±0.06)	0.21 (±0.04)	0.2 (±0.04)	0.18 (±0.05)	0.14 (±0.05)	0.11 (±0.06)	0.1 (±0.07)	0.14 (±0.05)	0.17 (±0.04)	0.24 (±0.04)	0.31 (±0.04)	0.38 (±0.04)	0.53 (±0.04)	0.61 (±0.04)	0.68 (±0.04)	0.77 (±0.04)	0.84 (±0.04)	0.87 (±0.05)
MERV 8,2" (Airguard)	0.3 (±0.1)	0.28 (±0.07)	0.24 (±0.07)	0.2 (±0.07)	0.17 (±0.07)	0.15 (±0.07)	0.15 (±0.06)	0.17 (±0.06)	0.19 (±0.07)	0.19 (±0.04)	0.2 (±0.04)	0.21 (±0.04)	0.23 (±0.04)	0.26 (±0.04)	0.3 (±0.04)	0.34 (±0.04)	0.37 (±0.04)	0.43 (±0.04)	0.51 (±0.04)	0.59 (±0.05)
MERV 8,2" (Airguard)	0.53 (±0.18)	0.37 (±0.07)	0.27 (±0.06)	0.24 (±0.05)	0.23 (±0.04)	0.19 (±0.05)	0.14 (±0.05)	0.11 (±0.06)	0.1 (±0.06)	0.15 (±0.05)	0.16 (±0.05)	0.19 (±0.05)	0.21 (±0.05)	0.24 (±0.05)	0.3 (±0.05)	0.35 (±0.04)	0.4 (±0.04)	0.46 (±0.05)	0.54 (±0.05)	0.59 (±0.06)
MERV 8,4" (Airguard)	0.52 (±0.1)	0.35 (±0.06)	0.28 (±0.06)	0.28 (±0.04)	0.25 (±0.04)	0.2 (±0.05)	0.15 (±0.06)	0.13 (±0.06)	0.12 (±0.07)	0.11 (±0.04)	0.11 (±0.04)	0.12 (±0.04)	0.14 (±0.04)	0.15 (±0.04)	0.2 (±0.04)	0.22 (±0.04)	0.25 (±0.05)	0.3 (±0.05)	0.38 (±0.05)	0.48 (±0.06)
MERV 8,4" (Airguard)	0.59 (±0.13)	0.56 (±0.07)	0.47 (±0.07)	0.43 (±0.06)	0.4 (±0.05)	0.34 (±0.06)	0.28 (±0.08)	0.23 (±0.08)	0.22 (±0.08)	0.2 (±0.05)	0.22 (±0.05)	0.24 (±0.05)	0.25 (±0.05)	0.27 (±0.05)	0.32 (±0.06)	0.36 (±0.06)	0.39 (±0.06)	0.44 (±0.06)	0.52 (±0.05)	0.6 (±0.06)
MERV 8,2" (Flanders)	0.56 (±0.15)	0.63 (±0.08)	0.63 (±0.08)	0.58 (±0.06)	0.52 (±0.05)	0.46 (±0.06)	0.42 (±0.06)	0.41 (±0.07)	0.42 (±0.07)	0.26 (±0.06)	0.2 (±0.05)	0.13 (±0.05)	0.08 (±0.05)	0.04 (±0.05)	0.1 (±0.05)	0.1 (±0.06)	0.12 (±0.06)	0.2 (±0.07)	0.35 (±0.06)	0.46 (±0.07)
MERV 8,1" (AirRelief Tex-air)	0.53 (±0.14)	0.51 (±0.09)	0.42 (±0.08)	0.36 (±0.08)	0.32 (±0.06)	0.29 (±0.05)	0.26 (±0.05)	0.24 (±0.06)	0.25 (±0.07)	0.26 (±0.04)	0.3 (±0.04)	0.36 (±0.04)	0.42 (±0.04)	0.49 (±0.04)	0.56 (±0.04)	0.62 (±0.04)	0.66 (±0.04)	0.73 (±0.04)	0.81 (±0.04)	0.85 (±0.05)
MERV 8,2" (AirRelief Tex-air)	0.73 (±0.1)	0.76 (±0.09)	0.76 (±0.09)	0.73 (±0.07)	0.7 (±0.06)	0.68 (±0.06)	0.67 (±0.07)	0.68 (±0.08)	0.69 (±0.1)	0.58 (±0.06)	0.53 (±0.06)	0.39 (±0.06)	0.32 (±0.05)	0.23 (±0.05)	0.25 (±0.04)	0.28 (±0.04)	0.36 (±0.04)	0.51 (±0.05)	0.73 (±0.04)	0.84 (±0.05)
MERV 8,4" (AirRelief Tex-air)	0.72 (±0.1)	0.77 (±0.06)	0.75 (±0.07)	0.71 (±0.06)	0.69 (±0.05)	0.67 (±0.05)	0.67 (±0.06)	0.67 (±0.06)	0.67 (±0.09)	0.61 (±0.05)	0.53 (±0.05)	0.4 (±0.05)	0.34 (±0.05)	0.28 (±0.05)	0.33 (±0.06)	0.41 (±0.06)	0.47 (±0.06)	0.55 (±0.07)	0.64 (±0.06)	0.72 (±0.06)
MERV 8,2" (Quality Filters ODORBAN)	0.53 (±0.14)	0.58 (±0.09)	0.56 (±0.07)	0.51 (±0.07)	0.47 (±0.08)	0.43 (±0.08)	0.42 (±0.08)	0.43 (±0.08)	0.47 (±0.1)	0.45 (±0.06)	0.42 (±0.06)	0.36 (±0.07)	0.35 (±0.07)	0.34 (±0.07)	0.42 (±0.07)	0.48 (±0.06)	0.53 (±0.06)	0.62 (±0.05)	0.72 (±0.05)	0.76 (±0.06)
MERV 8,2" (Quality Filters)	0.8 (±0.09)	0.75 (±0.06)	0.69 (±0.06)	0.67 (±0.05)	0.65 (±0.04)	0.6 (±0.05)	0.53 (±0.06)	0.49 (±0.06)	0.46 (±0.07)	0.38 (±0.05)	0.4 (±0.05)	0.44 (±0.05)	0.48 (±0.05)	0.52 (±0.04)	0.59 (±0.04)	0.63 (±0.04)	0.68 (±0.04)	0.72 (±0.04)	0.78 (±0.04)	0.81 (±0.05)
MERV 11,1" (Airguard)	0.35 (±0.09)	0.37 (±0.06)	0.4 (±0.06)	0.42 (±0.06)	0.44 (±0.05)	0.48 (±0.05)	0.5 (±0.05)	0.48 (±0.07)	0.43 (±0.08)	0.4 (±0.04)	0.42 (±0.04)	0.47 (±0.04)	0.51 (±0.04)	0.55 (±0.04)	0.62 (±0.04)	0.65 (±0.04)	0.69 (±0.04)	0.73 (±0.04)	0.76 (±0.04)	0.79 (±0.05)

MERV 11,2" (Airguard)	0.81 (±0.14)	0.81 (±0.12)	0.81 (±0.08)	0.82 (±0.06)	0.82 (±0.06)	0.82 (±0.07)	0.82 (±0.07)	0.83 (±0.07)	0.84 (±0.07)	0.76 (±0.05)	0.74 (±0.05)	0.67 (±0.05)	0.6 (±0.06)	0.45 (±0.1)	0.48 (±0.12)	0.56 (±0.09)	0.62 (±0.08)	0.71 (±0.08)	0.77 (±0.08)	0.82 (±0.07)
MERV 11,4" (Airguard)	0.67 (±0.12)	0.66 (±0.08)	0.63 (±0.09)	0.63 (±0.08)	0.62 (±0.08)	0.61 (±0.08)	0.6 (±0.08)	0.6 (±0.07)	0.59 (±0.09)	0.63 (±0.06)	0.57 (±0.07)	0.41 (±0.07)	0.32 (±0.07)	0.21 (±0.06)	0.27 (±0.05)	0.35 (±0.05)	0.42 (±0.05)	0.52 (±0.05)	0.68 (±0.05)	0.8 (±0.05)
MERV 11,2" (Flanders)	0.49 (±0.14)	0.58 (±0.08)	0.59 (±0.07)	0.52 (±0.06)	0.47 (±0.06)	0.42 (±0.07)	0.38 (±0.07)	0.36 (±0.08)	0.35 (±0.13)	0.27 (±0.1)	0.23 (±0.08)	0.19 (±0.05)	0.21 (±0.04)	0.25 (±0.05)	0.36 (±0.05)	0.46 (±0.04)	0.54 (±0.05)	0.63 (±0.04)	0.73 (±0.04)	0.79 (±0.06)
MERV 11,1" (AirRelief Tex-air)	0.62 (±0.11)	0.64 (±0.07)	0.63 (±0.07)	0.6 (±0.07)	0.56 (±0.05)	0.52 (±0.05)	0.49 (±0.06)	0.47 (±0.06)	0.46 (±0.07)	0.45 (±0.05)	0.44 (±0.05)	0.39 (±0.05)	0.36 (±0.05)	0.33 (±0.06)	0.38 (±0.06)	0.46 (±0.06)	0.53 (±0.06)	0.61 (±0.05)	0.7 (±0.05)	0.75 (±0.05)
MERV 11,2" (AirRelief Tex-air)	0.45 (±0.21)	0.47 (±0.22)	0.43 (±0.25)	0.4 (±0.24)	0.41 (±0.21)	0.42 (±0.19)	0.42 (±0.18)	0.41 (±0.17)	0.39 (±0.17)	0.4 (±0.12)	0.36 (±0.09)	0.32 (±0.06)	0.31 (±0.06)	0.3 (±0.07)	0.38 (±0.07)	0.42 (±0.05)	0.48 (±0.06)	0.54 (±0.05)	0.59 (±0.08)	0.56 (±0.19)
MERV 11,4" (AirRelief Tex-air)	0.76 (±0.11)	0.79 (±0.08)	0.77 (±0.06)	0.74 (±0.05)	0.7 (±0.04)	0.68 (±0.05)	0.67 (±0.06)	0.68 (±0.07)	0.69 (±0.09)	0.58 (±0.06)	0.54 (±0.06)	0.46 (±0.05)	0.45 (±0.05)	0.43 (±0.05)	0.47 (±0.05)	0.5 (±0.04)	0.54 (±0.04)	0.64 (±0.04)	0.78 (±0.04)	0.86 (±0.05)
MERV 11,2" (QualityFilters) (1)	0.55 (±0.12)	0.55 (±0.12)	0.52 (±0.14)	0.51 (±0.07)	0.5 (±0.05)	0.51 (±0.05)	0.52 (±0.06)	0.54 (±0.06)	0.56 (±0.08)	0.53 (±0.05)	0.6 (±0.05)	0.66 (±0.04)	0.69 (±0.04)	0.72 (±0.04)	0.76 (±0.04)	0.79 (±0.04)	0.81 (±0.04)	0.84 (±0.04)	0.87 (±0.04)	0.89 (±0.05)
MERV 11,2" (QualityFilters) (2)	0.64 (±0.15)	0.69 (±0.1)	0.65 (±0.1)	0.59 (±0.11)	0.57 (±0.1)	0.56 (±0.1)	0.56 (±0.11)	0.57 (±0.11)	0.58 (±0.11)	0.5 (±0.13)	0.58 (±0.1)	0.67 (±0.08)	0.72 (±0.08)	0.77 (±0.07)	0.81 (±0.06)	0.84 (±0.06)	0.85 (±0.06)	0.89 (±0.05)	0.93 (±0.05)	0.95 (±0.05)
MERV 11,2" (QualityFilters) (3)	0.6 (±0.15)	0.62 (±0.07)	0.58 (±0.09)	0.57 (±0.08)	0.57 (±0.08)	0.57 (±0.09)	0.58 (±0.1)	0.59 (±0.1)	0.61 (±0.1)	0.48 (±0.09)	0.53 (±0.08)	0.65 (±0.06)	0.72 (±0.05)	0.78 (±0.05)	0.82 (±0.04)	0.84 (±0.04)	0.86 (±0.04)	0.89 (±0.04)	0.94 (±0.04)	0.96 (±0.05)
MERV 11,2" (QualityFilters)	0.6 (±0.14)	0.62 (±0.17)	0.59 (±0.19)	0.56 (±0.15)	0.55 (±0.14)	0.55 (±0.15)	0.55 (±0.15)	0.57 (±0.16)	0.58 (±0.17)	0.5 (±0.16)	0.57 (±0.14)	0.66 (±0.11)	0.71 (±0.1)	0.76 (±0.09)	0.8 (±0.09)	0.82 (±0.08)	0.84 (±0.08)	0.87 (±0.08)	0.91 (±0.07)	0.93 (±0.09)
MERV 13,1" (Airguard)	0.9 (±0.1)	0.82 (±0.07)	0.75 (±0.07)	0.75 (±0.05)	0.75 (±0.05)	0.73 (±0.05)	0.7 (±0.05)	0.68 (±0.05)	0.65 (±0.06)	0.6 (±0.04)	0.64 (±0.04)	0.69 (±0.04)	0.74 (±0.04)	0.78 (±0.04)	0.84 (±0.04)	0.88 (±0.04)	0.89 (±0.04)	0.91 (±0.04)	0.92 (±0.04)	0.93 (±0.05)
MERV 13,2" (Airguard)	0.7 (±0.1)	0.86 (±0.1)	0.75 (±0.1)	0.6 (±0.05)	0.57 (±0.05)	0.58 (±0.05)	0.6 (±0.06)	0.65 (±0.07)	0.7 (±0.07)	0.74 (±0.04)	0.8 (±0.04)	0.84 (±0.04)	0.87 (±0.04)	0.89 (±0.04)	0.91 (±0.04)	0.92 (±0.04)	0.93 (±0.04)	0.94 (±0.04)	0.95 (±0.04)	0.95 (±0.05)
MERV 13,4" (Airguard)	0.75 (±0.14)	0.72 (±0.14)	0.68 (±0.16)	0.67 (±0.17)	0.68 (±0.15)	0.7 (±0.13)	0.72 (±0.12)	0.74 (±0.12)	0.75 (±0.11)	0.77 (±0.08)	0.77 (±0.08)	0.71 (±0.08)	0.69 (±0.08)	0.67 (±0.08)	0.72 (±0.06)	0.76 (±0.05)	0.79 (±0.05)	0.85 (±0.05)	0.91 (±0.04)	0.95 (±0.05)
MERV 13,2" (Flanders)	0.61 (±0.12)	0.59 (±0.11)	0.56 (±0.12)	0.54 (±0.11)	0.52 (±0.1)	0.51 (±0.1)	0.51 (±0.1)	0.53 (±0.1)	0.59 (±0.1)	0.63 (±0.12)	0.62 (±0.11)	0.6 (±0.09)	0.61 (±0.06)	0.61 (±0.05)	0.68 (±0.04)	0.73 (±0.04)	0.77 (±0.04)	0.82 (±0.04)	0.87 (±0.04)	0.91 (±0.06)
MERV 13,1" (AirRelief Tex-air)	0.81 (±0.1)	0.68 (±0.07)	0.59 (±0.07)	0.56 (±0.07)	0.51 (±0.05)	0.42 (±0.05)	0.34 (±0.06)	0.31 (±0.07)	0.31 (±0.08)	0.42 (±0.07)	0.49 (±0.06)	0.56 (±0.06)	0.62 (±0.06)	0.67 (±0.06)	0.73 (±0.05)	0.77 (±0.04)	0.8 (±0.05)	0.83 (±0.05)	0.86 (±0.05)	0.87 (±0.05)
MERV 13,2" (AirRelief Tex-air)	0.8 (±0.1)	0.8 (±0.06)	0.75 (±0.06)	0.71 (±0.04)	0.68 (±0.04)	0.63 (±0.05)	0.57 (±0.06)	0.51 (±0.06)	0.47 (±0.07)	0.55 (±0.05)	0.61 (±0.05)	0.66 (±0.05)	0.7 (±0.05)	0.73 (±0.04)	0.78 (±0.04)	0.81 (±0.04)	0.83 (±0.04)	0.85 (±0.04)	0.88 (±0.04)	0.9 (±0.05)
MERV 13,4" (AirRelief Tex-air)	0.48 (±0.14)	0.62 (±0.07)	0.57 (±0.07)	0.46 (±0.07)	0.4 (±0.07)	0.37 (±0.08)	0.36 (±0.08)	0.37 (±0.08)	0.4 (±0.08)	0.54 (±0.04)	0.61 (±0.04)	0.69 (±0.04)	0.75 (±0.04)	0.8 (±0.04)	0.84 (±0.04)	0.87 (±0.04)	0.89 (±0.04)	0.93 (±0.04)	0.95 (±0.04)	0.96 (±0.05)
MERV 13,2" (QualityFilters)	0.73 (±0.12)	0.78 (±0.09)	0.75 (±0.09)	0.71 (±0.08)	0.7 (±0.09)	0.69 (±0.09)	0.7 (±0.09)	0.72 (±0.09)	0.75 (±0.09)	0.77 (±0.06)	0.75 (±0.06)	0.66 (±0.07)	0.61 (±0.07)	0.53 (±0.05)	0.6 (±0.04)	0.69 (±0.04)	0.74 (±0.04)	0.8 (±0.05)	0.85 (±0.04)	0.89 (±0.05)
MERV 16,5" (Healthy Solutions)	0.96 (±0.09)	0.98 (±0.06)	0.97 (±0.06)	0.96 (±0.04)	0.97 (±0.04)	0.97 (±0.04)	0.97 (±0.05)	0.98 (±0.05)	0.98 (±0.06)	0.99 (±0.04)	0.99 (±0.04)	0.99 (±0.04)	0.99 (±0.04)	0.99 (±0.04)	0.99 (±0.04)	1 (±0.04)	1 (±0.04)	1 (±0.04)	1 (±0.04)	1 (±0.05)
MPR 300,1" (3M)	0.29 (±0.11)	0.23 (±0.07)	0.23 (±0.08)	0.26 (±0.06)	0.26 (±0.05)	0.26 (±0.05)	0.25 (±0.05)	0.24 (±0.06)	0.24 (±0.07)	0.21 (±0.04)	0.24 (±0.04)	0.29 (±0.04)	0.34 (±0.04)	0.39 (±0.04)	0.48 (±0.05)	0.54 (±0.04)	0.57 (±0.04)	0.61 (±0.05)	0.63 (±0.05)	0.64 (±0.06)
MPR 300,1" (3M)	0.31 (±0.12)	0.26 (±0.07)	0.18 (±0.07)	0.14 (±0.05)	0.11 (±0.05)	0.09 (±0.06)	0.06 (±0.06)	0.04 (±0.06)	0.03 (±0.08)	0.06 (±0.04)	0.09 (±0.04)	0.14 (±0.04)	0.18 (±0.05)	0.24 (±0.04)	0.32 (±0.04)	0.38 (±0.04)	0.41 (±0.05)	0.45 (±0.05)	0.48 (±0.05)	0.48 (±0.06)
MPR 600,1" (3M)	0.46 (±0.18)	0.55 (±0.13)	0.58 (±0.12)	0.55 (±0.09)	0.52 (±0.08)	0.51 (±0.08)	0.51 (±0.08)	0.53 (±0.09)	0.56 (±0.11)	0.38 (±0.06)	0.4 (±0.08)	0.44 (±0.15)	0.49 (±0.18)	0.52 (±0.21)	0.6 (±0.21)	0.66 (±0.19)	0.7 (±0.18)	0.79 (±0.14)	0.87 (±0.09)	0.9 (±0.08)
MPR 1000,1" (3M) (1)	0.51 (±0.12)	0.47 (±0.08)	0.48 (±0.08)	0.47 (±0.07)	0.46 (±0.07)	0.46 (±0.07)	0.46 (±0.07)	0.49 (±0.06)	0.53 (±0.08)	0.51 (±0.04)	0.6 (±0.04)	0.7 (±0.04)	0.76 (±0.04)	0.8 (±0.04)	0.84 (±0.04)	0.86 (±0.04)	0.88 (±0.04)	0.91 (±0.04)	0.94 (±0.04)	0.94 (±0.05)

MPR 1000,1" (3M) (2)	0.6 (±0.14)	0.59 (±0.14)	0.55 (±0.16)	0.57 (±0.11)	0.58 (±0.1)	0.6 (±0.1)	0.61 (±0.1)	0.63 (±0.1)	0.63 (±0.11)	0.46 (±0.06)	0.53 (±0.05)	0.67 (±0.04)	0.75 (±0.04)	0.81 (±0.04)	0.85 (±0.04)	0.87 (±0.04)	0.89 (±0.04)	0.92 (±0.04)	0.95 (±0.04)	0.97 (±0.05)
MPR 1000,1" (3M) (3)	0.49 (±0.13)	0.5 (±0.08)	0.52 (±0.09)	0.54 (±0.08)	0.56 (±0.08)	0.57 (±0.08)	0.58 (±0.07)	0.59 (±0.07)	0.59 (±0.07)	0.55 (±0.05)	0.65 (±0.04)	0.76 (±0.04)	0.82 (±0.04)	0.85 (±0.04)	0.89 (±0.04)	0.9 (±0.04)	0.92 (±0.04)	0.94 (±0.04)	0.96 (±0.04)	0.96 (±0.05)
MPR 1000,1" (3M)	0.53 (±0.23)	0.52 (±0.18)	0.51 (±0.2)	0.53 (±0.15)	0.53 (±0.14)	0.54 (±0.14)	0.55 (±0.14)	0.57 (±0.14)	0.59 (±0.15)	0.51 (±0.09)	0.59 (±0.08)	0.71 (±0.07)	0.78 (±0.07)	0.82 (±0.07)	0.86 (±0.07)	0.88 (±0.06)	0.9 (±0.07)	0.92 (±0.07)	0.95 (±0.07)	0.96 (±0.08)
MPR 1000,4" (3M)	0.63 (±0.13)	0.65 (±0.1)	0.61 (±0.11)	0.58 (±0.1)	0.56 (±0.08)	0.56 (±0.08)	0.56 (±0.08)	0.58 (±0.09)	0.63 (±0.11)	0.69 (±0.08)	0.69 (±0.08)	0.66 (±0.06)	0.66 (±0.05)	0.67 (±0.04)	0.7 (±0.04)	0.76 (±0.06)	0.75 (±0.04)	0.78 (±0.05)	0.82 (±0.04)	0.86 (±0.05)
MPR 1550,4" (3M)	0.62 (±0.15)	0.61 (±0.15)	0.52 (±0.19)	0.52 (±0.13)	0.53 (±0.11)	0.54 (±0.1)	0.55 (±0.09)	0.57 (±0.09)	0.61 (±0.09)	0.68 (±0.09)	0.7 (±0.07)	0.7 (±0.05)	0.72 (±0.05)	0.74 (±0.04)	0.76 (±0.04)	0.79 (±0.04)	0.8 (±0.04)	0.83 (±0.04)	0.86 (±0.04)	0.88 (±0.05)
MPR 1900,1" (3M)	0.56 (±0.14)	0.54 (±0.13)	0.49 (±0.14)	0.48 (±0.1)	0.48 (±0.09)	0.49 (±0.09)	0.51 (±0.08)	0.55 (±0.07)	0.61 (±0.07)	0.56 (±0.1)	0.57 (±0.11)	0.55 (±0.11)	0.55 (±0.11)	0.54 (±0.09)	0.58 (±0.06)	0.59 (±0.05)	0.6 (±0.05)	0.64 (±0.05)	0.68 (±0.05)	0.7 (±0.06)
MPR 2200,1" (3M)	0.77 (±0.1)	0.64 (±0.1)	0.59 (±0.1)	0.66 (±0.07)	0.7 (±0.06)	0.72 (±0.07)	0.74 (±0.07)	0.76 (±0.06)	0.77 (±0.07)	0.77 (±0.06)	0.77 (±0.06)	0.75 (±0.05)	0.74 (±0.05)	0.68 (±0.05)	0.7 (±0.07)	0.75 (±0.06)	0.77 (±0.06)	0.81 (±0.07)	0.83 (±0.06)	0.85 (±0.06)
MPR 2800,1" (3M)	0.69 (±0.11)	0.69 (±0.09)	0.64 (±0.09)	0.61 (±0.08)	0.62 (±0.07)	0.64 (±0.07)	0.66 (±0.07)	0.69 (±0.06)	0.73 (±0.07)	0.82 (±0.04)	0.84 (±0.04)	0.85 (±0.04)	0.85 (±0.04)	0.86 (±0.04)	0.88 (±0.04)	0.9 (±0.04)	0.91 (±0.04)	0.92 (±0.04)	0.93 (±0.04)	0.94 (±0.05)
FPR 4,1" (Rheem)	0.31 (±0.16)	0.42 (±0.11)	0.44 (±0.12)	0.4 (±0.06)	0.38 (±0.05)	0.38 (±0.05)	0.39 (±0.06)	0.41 (±0.07)	0.42 (±0.1)	0.24 (±0.05)	0.24 (±0.05)	0.32 (±0.06)	0.37 (±0.07)	0.43 (±0.06)	0.48 (±0.05)	0.52 (±0.05)	0.54 (±0.05)	0.62 (±0.05)	0.74 (±0.04)	0.81 (±0.05)
FPR 7,1" (Honeywell)	0.34 (±0.1)	0.32 (±0.07)	0.28 (±0.07)	0.24 (±0.06)	0.23 (±0.05)	0.23 (±0.05)	0.24 (±0.06)	0.23 (±0.06)	0.21 (±0.07)	0.24 (±0.04)	0.26 (±0.04)	0.29 (±0.04)	0.32 (±0.04)	0.36 (±0.04)	0.42 (±0.04)	0.47 (±0.04)	0.5 (±0.04)	0.57 (±0.04)	0.65 (±0.04)	0.72 (±0.05)
FPR 9,1" (Honeywell)	0.7 (±0.1)	0.59 (±0.09)	0.51 (±0.09)	0.47 (±0.06)	0.46 (±0.05)	0.45 (±0.05)	0.45 (±0.05)	0.46 (±0.06)	0.48 (±0.06)	0.51 (±0.04)	0.56 (±0.04)	0.63 (±0.04)	0.68 (±0.04)	0.73 (±0.04)	0.78 (±0.04)	0.82 (±0.04)	0.84 (±0.04)	0.88 (±0.04)	0.91 (±0.04)	0.92 (±0.05)
FPR 10,1" (Honeywell)	0.41 (±0.17)	0.38 (±0.17)	0.35 (±0.2)	0.36 (±0.19)	0.35 (±0.17)	0.34 (±0.16)	0.33 (±0.17)	0.32 (±0.18)	0.33 (±0.22)	0.34 (±0.22)	0.3 (±0.21)	0.23 (±0.18)	0.2 (±0.15)	0.19 (±0.13)	0.25 (±0.12)	0.29 (±0.11)	0.36 (±0.12)	0.45 (±0.13)	0.58 (±0.11)	0.69 (±0.09)
FPR 10,4" (Honeywell)	0.5 (±0.17)	0.54 (±0.07)	0.53 (±0.09)	0.52 (±0.08)	0.48 (±0.09)	0.46 (±0.08)	0.46 (±0.07)	0.47 (±0.07)	0.52 (±0.08)	0.54 (±0.04)	0.6 (±0.04)	0.69 (±0.04)	0.73 (±0.04)	0.78 (±0.04)	0.83 (±0.04)	0.85 (±0.04)	0.87 (±0.04)	0.9 (±0.04)	0.92 (±0.04)	0.94 (±0.05)

Appendix B. Curve fitting equations from field measurements

B.1 Polynomial curve fits for size-resolved removal efficiencies

Figure B.1 shows polynomial curve fits through the size-resolved removal efficiency data for each of the tested (a) MERV-rated and (b) MPR-rated and FPR-rated filters for particle sizes 0.01-2.5 µm. Curve fitting equations and fit statistics for all 50 test filters are shown in Table B.1.

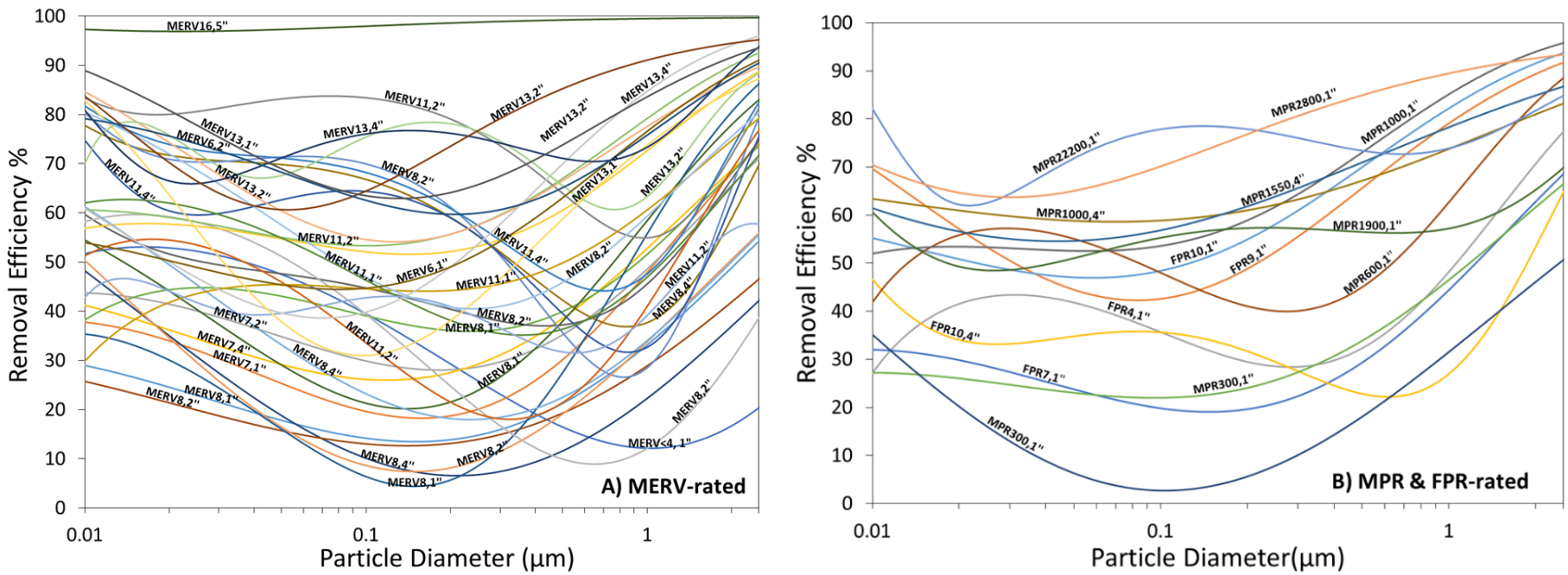

Figure B.1. Polynomial curve fits the measured size-resolved removal efficiency data of the 50 test filters: a) MERV and b) MPR and FPR filters. Note that 1" = 2.5 cm.

Table B.1. Polynomial curve fitting equations to fit to size-resolved removal efficiency results

Num	Manufacturer	Rating System	Depth, cm (in)	Model	Fitting Equation*	R^2
1	Flanders	< 4	2.5 (1)	Disposable panel	$y = -0.0936x^3 - 0.249x^2 + 0.0064x + 1.9437$	$R^2 = 0.92$
2	AirFilterBuy	6	2.5 (1)	AFB16x25x1M6	$y = -0.1068x^3 - 0.5468x^2 - 0.8133x + 1.3694$	$R^2 = 0.97$
3	AirFilterBuy	6	5.1 (2)	AFB16x25x2M6	$y = -0.154x^3 - 0.684x^2 - 0.7195x + 1.3837$	$R^2 = 0.98$
4	AirRelief Tex-air Filters	7	2.5 (1)	Minipleat	$y = -0.1094x^3 - 0.4777x^2 - 0.5562x + 1.7171$	$R^2 = 0.99$
5	AirRelief Tex-air Filters	7	5.1 (2)	Minipleat	$y = -0.0996x^3 - 0.4138x^2 - 0.4487x + 1.7112$	$R^2 = 0.98$
6	AirRelief Tex-air Filters	7	10.2 (4)	Minipleat	$y = -0.0703x^3 - 0.3575x^2 - 0.4813x + 1.6742$	$R^2 = 0.99$
7	WEB-ECO	8	2.5 (1)	FilterPlus	$y = -0.1498x^3 - 0.4962x^2 - 0.4459x + 1.6852$	$R^2 = 0.93$
8	Airguard	8	2.5 (1)	DP40-STD1-102	$y = -0.0516x^3 - 0.2501x^2 - 0.3069x + 1.8251$	$R^2 = 0.97$
9	Airguard	8	2.5 (1)	MX40-STD1-102	$y = -0.1826x^3 - 0.7909x^2 - 0.9336x + 1.646$	$R^2 = 0.99$
10	Airguard	8	5.1 (2)	DP40-STD2-202	$y = -0.0344x^3 - 0.1812x^2 - 0.2342x + 1.8519$	$R^2 = 0.97$
11	Airguard	8	5.1 (2)	MX40-STD2-202	$y = -0.0064x^3 - 0.2214x^2 - 0.3547x + 1.821$	$R^2 = 0.96$
12	Airguard	8	10.2 (4)	DP40-STD4-402	$y = -0.0143x^3 - 0.1942x^2 - 0.243x + 1.8905$	$R^2 = 0.92$
13	Airguard	8	10.2 (4)	MX40-STD4-402 (type dp 4-40 max)	$y = -0.0337x^3 - 0.2825x^2 - 0.3147x + 1.8193$	$R^2 = 0.98$
14	Flanders	8	5.1 (2)	PRE-PLEAT40 LPD	$y = -0.1654x^3 - 0.4963x^2 - 0.1695x + 1.9439$	$R^2 = 0.95$
15	AirRelief Tex-air Filters	8	2.5 (1)	Minipleat	$y = -0.1016x^3 - 0.5622x^2 - 0.7375x + 1.619$	$R^2 = 0.99$
16	AirRelief Tex-air Filters	8	5.1 (2)	Minipleat	$y = -0.4457x^4 - 1.7169x^3 - 1.9344x^2 - 0.2866x + 1.8542$	$R^2 = 0.94$
17	AirRelief Tex-air Filters	8	10.2 (4)	Minipleat	$y = -0.2449x^4 - 0.9751x^3 - 1.1613x^2 - 0.1575x + 1.7945$	$R^2 = 0.93$
18	QualityFilters	8	5.1 (2)	ODORBAN	$y = -0.135x^4 - 0.5705x^3 - 0.8382x^2 - 0.409x + 1.7361$	$R^2 = 0.93$
19	QualityFilters	8	5.1 (2)	Pleated panel	$y = -0.0883x^3 - 0.5397x^2 - 0.5667x + 1.6095$	$R^2 = 0.99$
20	Airguard	11	2.5 (1)	PWG-STD1-102	$y = -0.1547x^3 - 0.4871x^2 - 0.4806x + 1.5956$	$R^2 = 0.97$
21	Airguard	11	5.1 (2)	PWG-STD2-202	$y = -0.4086x^4 - 1.5695x^3 - 1.6304x^2 - 0.0352x + 1.6539$	$R^2 = 0.94$
22	Airguard	11	10.2 (4)	PWG-STD4-402	$y = -0.4283x^4 - 1.553x^3 - 1.5977x^2 - 0.1965x + 1.8281$	$R^2 = 0.90$
23	Flanders	11	5.1 (2)	PRE-PLEAT40	$y = -0.2499x^3 - 0.8427x^2 - 0.6441x + 1.7709$	$R^2 = 0.97$
24	AirRelief Tex-air Filters	11	2.5 (1)	Minipleat	$y = -0.3054x^4 - 1.2112x^3 - 1.5075x^2 - 0.3844x + 1.7194$	$R^2 = 0.96$
25	AirRelief Tex-air Filters	11	5.1 (2)	Minipleat	$y = 0.3062x^6 + 1.4689x^5 + 2.2259x^4 + 0.759x^3 - 0.7358x^2 - 0.405x + 1.7846$	$R^2 = 0.96$

26	AirRelief Tex-air Filters	11	10.2 (4)	Minipleat	$y = -0.3054x^4 - 1.2112x^3 - 1.5075x^2 - 0.3844x + 1.7194$	$R^2 = 0.96$
27	QualityFilters	11	5.1 (2)	MQP Pleated panel	$y = -0.141x^3 - 0.6352x^2 - 0.8452x + 1.318$	$R^2 = 0.98$
28	Airguard	13	2.5 (1)	Dp-13-STD1-102	$y = -0.0207x^3 - 0.4958x^2 - 0.8226x + 1.2147$	$R^2 = 0.94$
29	Airguard	13	5.1 (2)	DP13-STD2-202	$y = 0.1721x^3 + 0.0465x^2 - 0.7257x + 0.9508$	$R^2 = 0.93$
30	Airguard	13	10.2 (4)	DP13-STD4-402	$y = -0.5058x^4 - 1.792x^3 - 1.8609x^2 - 0.5281x + 1.4256$	$R^2 = 0.98$
31	Flanders	13	5.1 (2)	Pre-Pleated 40	$y = -0.1574x^3 - 0.614x^2 - 0.6997x + 1.4371$	$R^2 = 0.96$
32	AirRelief Tex-air Filters	13	2.5 (1)	Minipleat	$y = 0.1044x^3 - 0.1998x^2 - 0.7248x + 1.4181$	$R^2 = 0.99$
33	AirRelief Tex-air Filters	13	5.1 (2)	Minipleat	$y = 0.0002x^3 - 0.3878x^2 - 0.6945x + 1.3507$	$R^2 = 0.97$
34	AirRelief Tex-air Filters	13	10.2 (4)	Minipleat	$y = -0.0907x^3 - 0.6631x^2 - 1.1675x + 1.1842$	$R^2 = 0.99$
35	QualityFilters	13	5.1 (2)	GQP Pleated panel	$y = 0.8024x^6 + 3.4114x^5 + 3.9456x^4 - 0.4539x^3 - 2.4976x^2 - 0.5347x + 1.5647$	$R^2 = 0.95$
36	Healthy Solutions Climate	16	12.7 (5)	Carbon clean	$y = 0.126x^3 + 0.1322x^2 - 0.6062x - 0.3045$	$R^2 = 0.97$
37	3M Filtrete	300	2.5 (1)	Basic Dust Clean Living	$y = -0.0629x^3 - 0.2856x^2 - 0.3864x + 1.7284$	$R^2 = 0.96$
38	3M Filtrete	300	2.5 (1)	Clean Living Dust Reduction	$y = 0.0071x^3 - 0.143x^2 - 0.3025x + 1.8357$	$R^2 = 0.97$
39	3M Filtrete	600	2.5 (1)	Filtrete Clean Living	$y = -0.321x^3 - 1.0103x^2 - 0.8325x + 1.5725$	$R^2 = 0.98$
40	3M Filtrete	1000	2.5 (1)	Micro Allergen Defense	$y = -0.1658x^3 - 0.737x^2 - 1.065x + 1.1728$	$R^2 = 0.98$
41	3M Filtrete	1000	10.2 (4)	Micro Allergen Reduction Filter	$y = -0.0362x^3 - 0.2314x^2 - 0.3901x + 1.4191$	$R^2 = 0.92$
42	3M Filtrete	1550	10.2 (4)	High Performance Allergen Reduction Filter	$y = 0.0001x^3 - 0.173x^2 - 0.4709x + 1.3371$	$R^2 = 0.98$
43	3M Filtrete	1900	2.5 (1)	High Performance Maximum Allergen Reduction Filter	$y = -0.158x^4 - 0.5037x^3 - 0.4423x^2 - 0.1158x + 1.6312$	$R^2 = 0.92$
44	3M Filtrete	2200	2.5 (1)	Filtrete Healthy Living	$y = 0.2272x^5 + 0.491x^4 - 0.2715x^3 - 0.8542x^2 - 0.2472x + 1.4168$	$R^2 = 0.92$
45	3M Filtrete	2800	2.5 (1)	Ultrafine Particle Reduction Health Living	$y = 0.0793x^3 + 0.009x^2 - 0.5233x + 1.0219$	$R^2 = 0.99$
46	Rheem	FPR4	2.5 (1)	Dust & Pollen	$y = -0.2336x^3 - 0.7205x^2 - 0.5804x + 1.7148$	$R^2 = 0.96$
47	Honeywell	FPR7	2.5 (1)	Allergen Plus Air Filter	$y = -0.0899x^3 - 0.3849x^2 - 0.4538x + 1.7452$	$R^2 = 0.99$

48	Honeywell	FPR9	2.5 (1)	Superior Allergen Air Filter	$y = -0.0239x^3 - 0.4292x^2 - 0.8483x + 1.321$	$R^2 = 0.99$
49	Honeywell	FPR10	2.5 (1)	Elite Allergen Air Filter	$y = -0.2045x^4 - 0.7799x^3 - 0.9215x^2 - 0.2912x + 1.8636$	$R^2 = 0.97$
50	Honeywell	FPR10	10.2 (4)	Ultimate Allergen Air Filter	$y = -0.0923x^3 - 0.5386x^2 - 0.9081x + 1.2507$	$R^2 = 0.99$

*Note that the polynomial curve fits are fit through the logarithm of the percent penetration for each measured particle size 0.01 to 2.5 µm (on the y-axis) and particle diameter (on the x-axis).

Appendix C. Indoor particle size distributions gathered from the literature

Table C.1. Summary of indoor PSD references

Ref #	Reference	No. of PSDs	PSD No.
1	Hussein et al.[1]	36	1~36
2	Hussein et al.[2]	25	37~61
3	Lazaridis et al.[3]	33	62~94
4	Ji et al.[4]	3	95~97
5	Vette et al.[5]	4	98~101
6	See et al.[6]	12	102~113
7	McAuley et al.[7]	9	114~122
8	Wan et al.[8]	10	123~132
9	Tu et al.[9]	8	133~140
10	Guo et al.[10]	10	141~150
11	He et al.[11]	3	151~153
12	Li et al.[12]	20	154~173
13	Parker et al.[13]	2	174~175
14	Wallace et al.[14]	4	176~179
15	Buonanno et al.[15]	10	180~189
16	Yeung et al.[16]	12	190~201

Table C.2. Summary of 201 indoor particle size distributions from the existing literature and bi- and tri-modal fit statistics

PSD No.	Ref Num	Total UFP (#/cm^3)	Total $PM_{2.5}$ (µg/m^3)	MODE 1			MODE 2			MODE 3			Sources	Sampling time
				N (#/cm^3)	GM (µm)	logGSD	N (#/cm^3)	GM (µm)	logGSD	N (#/cm^3)	GM (µm)	logGSD		
1	1	629.8	1170.7	303	0.029	0.176	693	0.105	0.243	176	0.311	0.196	Aroma Lamp	Sampling background
2	1	489.8	1001.4	215	0.024	0.267	655	0.109	0.252	148	0.339	0.173	Aroma Lamp	Start
3	1	674.9	1138.6	442	0.025	0.173	611	0.119	0.252	90.4	0.359	0.173	Aroma Lamp	Start 30min
4	1	941.1	1981.4	375	0.025	0.170	1362	0.114	0.250	248	0.271	0.179	Aroma lamp	Start 45min
5	1	1327.6	3213.2	279	0.022	0.167	2743	0.122	0.278	197	0.244	0.133	Aroma lamp	Start 60min
6	1	3047.8	3657.4	2964	0.023	0.238	799	0.138	0.318	85.2	0.141	0.173	Aroma Lamp	Extinguished
7	1	1445.9	1991	1275	0.029	0.215	377	0.107	0.209	359	0.213	0.277	Aroma Lamp	Extinguished 15min
8	1	774.4	1345.8	403	0.027	0.190	174	0.112	0.169	783	0.132	0.471	Aroma Lamp	Extinguished 45min
9	1	614.0	1146.1	429	0.025	0.294	597	0.118	0.236	158	0.382	0.195	Aroma Lamp	Extinguished 75min
10	1	425.3	784.2	166	0.031	0.214	222	0.056	0.127	398	0.158	0.161	Candle	Background
11	1	4707.1	7799.4	2157	0.044	0.313	5558	0.099	0.227	128	0.229	0.0899	Candle	Started
12	1	4364.0	6915.7	1722	0.024	0.2671	4369	0.094	0.235	958	0.115	0.209	Candle	Lighting 15min
13	1	3406.0	4966.8	1753	0.015	0.1335	2773	0.091	0.2988	607	0.113	0.3117	Candle	Extinguished
14	1	4405.0	5925.0	2908	0.018	0.0827	2986	0.098	0.2922	125	0.256	0.173	Candle	Extinguished 15min
15	1	2673.2	3901.5	1373	0.018	0.0827	2515	0.098	0.2922	15.8	0.29	0.0530	Candle	Extinguished 45min
16	1	1636.7	2728.6	683	0.017	0.1205	1719	0.094	0.2718	346	0.175	0.187	Candle	Extinguished 75min
17	1	18069.9	45383.7	40350	0.108	0.201	5043	0.334	0.3012	-	-	-	Cooking	Sampling Start
18	1	190967	233086	168000	0.042	0.1986	9000	0.149	0.301	56230	0.106	0.158	Cooking	Maximum effect
19	1	137736	160310	80420	0.04	0.238	74620	0.061	0.235	5907	1.747	0.0791	Cooking	Cooking after 1hr
20	1	34432.4	47461.5	90.4	0.017	0.0211	41710	0.069	0.217	5664	0.133	0.298	Cooking	Cooking after 1.5hr
21	1	650.3	131.6	502	0.018	0.0828	23400	0.084	0.248	9441	2.316	0.146	Cooking	after 2hr
22	1	649.1	1416.5	138	0.032	0.1106	1195	0.117	0.346	84.8	0.163	0.107	Hair spray	First time sampling background

23	1	577.9	1525.9	96	0.033	0.146	1129	0.123	0.28	302	0.232	0.375	Hair spray	Second time sampling background
24	1	949.4	2460.2	381	0.061	0.29	1191	0.103	0.27	890	0.257	0.244	Hair spray	Start
25	1	1004.9	2665	169	0.03	0.069	1678	0.098	0.28	861	0.279	0.274	Hair spray	Maximum effect
26	1	863.8	2338.9	565	0.081	0.285	1717	0.155	0.346	58.2	0.229	0.143	Hair spray	after 45min
27	1	632.1	1894.2	11.7	0.031	0.155	802	0.094	0.296	1036	0.188	0.294	Hair spray	after 1.5hr
28	1	870.8	1645.2	552	0.0378	0.243	879	0.1182	0.243	219	0.2512	0.182	Kitchen	-
29	1	871.3	1658.1	547	0.0376	0.243	893	0.1182	0.243	223	0.2512	0.176	Living Room	-
30	1	591.1	1659.1	279	0.043	0.287	1360	0.156	0.283	24	0.265	0.089	Tobacco	Background
31	1	1583.9	2560.8	2403	0.076	0.301	101	0.135	0.072	60.9	0.429	0.0607	Tobacco	Smoking Started
32	1	12471.9	39816.8	118	0.018	0.301	38730	0.132	0.248	1000	0.8	0.204	Tobacco	Maximum effect
33	1	4661.7	21485.9	33	0.021	0.0453	2093	0.099	0.196	19360	0.164	0.232	Tobacco	Extinguished 1hr
34	1	2141.4	13630.9	146	0.031	0.124	7652	0.135	0.182	5833	0.251	0.196	Tobacco	Extinguished After 1.5hr
35	1	1019.7	8158.9	1200	0.164	0.301	764	0.118	0.133	6195	0.199	0.209	Tobacco	Extinguished After 2hr
36	1	1177.9	7545.9	523	0.049	0.34	2585	0.135	0.149	4449	0.212	0.201	Tobacco	Extinguished After 3hr
37	2	4931.5	5978.8	19200	0.006	0.204	2020	0.053	0.2253	1300	0.127	0.278	Heating	19:09pm on Feb3
38	2	7031.9	9685.7	39340	0.006	0.176	2700	0.07	0.2253	2900	0.127	0.198	Heating	19:41pm on Feb3
39	2	7222.5	8288.3	18790	0.008	0.176	2670	0.08	0.2504	150	0.335	0.146	Sauna	20:04pm on Feb3
40	2	6235.7	7221.7	10630	0.009	0.164	2280	0.061	0.290	800	0.113	0.212	Sauna	20:22pm on Feb3
41	2	11172.7	12944.8	18230	0.01	0.217	3300	0.085	0.238	530	0.296	0.146	Fireplace started+ Sauna	20:41pm on Feb3
42	2	9390.1	10628.8	8560	0.009	0.146	5390	0.026	0.238	2230	0.106	0.212	Fireplace+ Sauna	21:07pm on Feb3
43	2	7012.2	8321.9	3070	0.012	0.130	4540	0.037	0.29	1660	0.12	0.274	Fireplace + light cooking	21:39pm on Feb3
44	2	3013.9	3807.1	1070	0.015	0.222	2190	0.049	0.232	780	0.152	0.243	No sources	23:13pm on Feb3
45	2	5213.9	5789.8	610	0.015	0.255	5020	0.05	0.190	310	0.206	0.155	Cooking breakfast	07:30am on Feb7
46	2	3795.8	4323.9	970	0.014	0.255	3320	0.05	0.204	310	0.219	0.161	People Leaving	08:59am on Feb7
47	2	5509.5	5962.7	860	0.015	0.204	4850	0.043	0.164	420	0.206	0.198	People Arrival	12:36pm on Feb7

48	2	8904.5	9623.7	1470	0.023	0.204	7960	0.053	0.179	250	0.279	0.146	Cooking Lunch	14:46pm on Feb7
49	2	6320.2	7017.7	1060	0.014	0.204	5860	0.05	0.196	350	0.262	0.155	Winding	16:36pm on Feb7
50	2	4100.6	4876.8	1700	0.012	0.294	3350	0.041	0.285	550	0.219	0.274	Cleaning	18:54pm on Feb7.
51	2	5730.7	6569.1	1010	0.014	0.204	5170	0.043	0.222	640	0.206	0.217	Dinner	22:37pm on Feb7
52	2	2174.9	2666.7	5210	0.007	0.255	820	0.057	0.225	430	0.219	0.278	Sauna	19:19pm on Feb9
53	2	8066.8	8767.2	13560	0.01	0.179	1480	0.049	0.290	520	0.219	0.204	Sauna	19:55pm on Feb9
54	2	38262.8	91498.5	6790	0.011	0.2041	28840	0.055	0.294	58890	0.162	0.2304	Sauna + Fireplace + Heavy cooking	20:13pm on Feb9
55	2	61684.3	100186	22850	0.031	0.292	73300	0.092	0.283	5120	0.296	0.146	Sauna +Fireplace +Heavy cooking	20:25pm on Feb9
56	2	30825.8	46089.4	6680	0.012	0.2856	21890	0.049	0.252	20200	0.127	0.278	Sauna +Fireplace +Intermediate	20:38pm on Feb9
57	2	10860.5	14708.4	5460	0.018	0.243	4330	0.049	0.243	5730	0.12	0.278	Fireplace and Lightcooking-1	20:59pm on Feb9
58	2	5321.7	7403.3	2320	0.018	0.243	2640	0.049	0.243	2790	0.132	0.296	Fireplace and Lightcooking-2	21:23pm on Feb9
59	2	1337.5	1977.1	630	0.016	0.262	1040	0.057	0.294	450	0.236	0.212	-	18:43pm on Feb9
60	2	1560.2	2073.5	700	0.015	0.255	1100	0.05	0.267	450	0.194	0.296	-	during workday
61	2	1312.9	2184.3	400	0.014	0.243	1000	0.041	0.243	900	0.2512	0.296	-	during weekend.
62	3	23428.2	29878.6	2176	0.016	0.117	1950	0.014	0.478	27390	0.053	0.38	- (Athens)	during March and December
63	3	6100.7	9132.5	3909	0.037	0.255	4459	0.097	0.271	816	0.192	0.204	Limited indoor activities at Milan	at night when office was unoccupied during autumn period

64	3	1654.9	2166.1	904	0.016	0.264	1441	0.074	0.32	25.1	0.225	0.068	- (Oslo)	09:00 and 14:00 during the summer time
65	3	1284.1	2451.9	528	0.036	0.155	1861	0.116	0.255	63.1	0.391	0.1003	Indoor at Prague	during November
66	3	18837.6	23392.0	170	0.012	0.041	17660	0.046	0.2405	5630	0.116	0.367	Frying at Oslo	0min
67	3	49367.4	71148.1	1597	0.011	0.086	68910	0.073	0.2671	1188	0.218	0.0934	Frying at Oslo	5min
68	3	81659.6	126303	29600	0.073	0.33	96850	0.084	0.22	-	-	-	Frying at Oslo	10min
69	3	104415	1082	1855	0.034	0.0644	134500	0.083	0.204	37900	0.137	0.361	Frying at Oslo	15min
70	3	103723	20.497	301	0.012	0.0569	53310	0.089	0.198	121700	0.09	0.238	Frying at Oslo	20min
71	3	91670.5	18.42	893	0.027	0.0863	146000	0.093	0.217	2384	0.249	0.114	Frying at Oslo	After frying 25min
af72	3	59153.1	187.3	810	0.014	0.0969	113100	0.099	0.212	1238	0.291	0.0863	Frying at Oslo	After frying-35min
73	3	43404.3	154.2	298	0.018	0.0293	6706	0.09	0.309	81330	0.103	0.2068	Frying at Oslo	After frying-45min
74	3	31834.4	118.1	773	0.015	0.0828	66410	0.105	0.209	477	0.236	0.0293	Frying at Oslo	After frying-55min
75	3	30150.5	126.5	30100	0.035	0.198	182	0.089	0.041	2406	0.23	0.303	Frying at Prague	0min
76	3	74748.1	11.2	75560	0.035	0.198	194	0.087	0.021	1061	0.209	0.1105	Frying at Prague	5min
77	3	125601	12.3	42380	0.025	0.278	88020	0.038	0.18	1068	0.186	0.097	Frying at Prague	10min
78	3	145088	99.2	146400	0.037	0.195	3951	0.173	0.301	-	-	-	Frying at Prague	15min
79	3	138534	45.8	125800	0.037	0.193	15390	0.058	0.161	1670	0.228	0.225	Frying at Prague	After frying-20min
80	3	91670.5	18.4	65420	0.04	0.178	25230	0.057	0.158	5999	0.094	0.2304	Frying at Prague	After frying-25min
81	3	58931.3	8.8	59400	0.052	0.167	2071	0.05	0.176	-	-	-	Frying at Prague	After frying-30min
82	3	32371.2	60.2	17040	0.045	0.127	16470	0.068	0.123	1989	0.204	0.278	Frying at Prague	After frying-40min
83	3	97835.9	1202	8359	0.036	0.245	148800	0.084	0.301	18050	0.346	0.173	Smoking at Milan	-
84	3	113383	526.4	3115	0.022	0.143	161100	0.092	0.255	50100	0.119	0.257	Smoking two Cigarettes at Milan	-
85	3	42638.5	413.2	305	0.012	0.079	91400	0.107	0.274	1885	0.369	0.0934	Smoking at Oslo	-

86	3	16369.1	468.9	174	0.055	0.021	30740	0.108	0.22	14540	0.193	0.292	Burning two cigarettes at Milan	Background
87	3	14046.7	281.6	210	0.029	0.0253	16870	0.079	0.276	10100	0.156	0.332	Smoking at Milan	Background
88	3	535.6	6.9	220	0.026	0.176	740	0.111	0.23	150	0.339	0.146	Without indoor source at Prague (occupied)	-
89	3	1474.2	3.3	750	0.014	0.204	830	0.049	0.17	580	0.156	0.204	Without indoor source at Oslo (occupied)	-
90	3	3565.4	15.8	140	0.022	0.204	3700	0.054	0.2304	1700	0.183	0.204	Without indoor source at Milan (occupied)	-
91	3	22879	277.5	15500	0.01	0.322	17300	0.054	0.265	4000	0.256	0.301	Without indoor source at Athens (occupied)	-
92	3	63615.7	1101	33500	0.011	0.301	48000	0.045	0.255	13000	0.2560	0.322	With indoor source at Athens	during march and December
93	3	4809.6	8.4	1850	0.006	0.2304	1900	0.021	0.146	4950	0..097	0.2304	With indoor source at Oslo	09:00 and 14:00 during the summer time
94	3	6808.6	17.6	5900	0.031	0.176	2000	0.105	0.204	200	0.369	0.204	With indoor source at Prague	during November
95	4	10743	22641	20070	0.002	0.563	14050	0.086	0.269	6440	0.231	0.181	Burning special incense	5min to 20min
96	4	4193.5	5488.5	3121	0.011	0.326	3358	0.064	0.309	428	0.172	0.127	Burning special incense	5min to 20min before the incense was lighted.
97	4	6273.3	107.6	6567	0.005	0.1903	10770	0.09	0.245	6177	0.239	0.173	Burning special incense	From lighting incense to end
98	5	763.9	1181.6	452	0.035	0.24	735	0.109	0.257	-	-	-	-	Winter daytime

99	5	881.1	1425.1	102	0.026	0.217	1307	0.086	0.278	19.5	0.845	0.158	-	Winter nighttime
100	5	1000.7	1321.9	629	0.042	0.212	697	0.087	0.357	-	-	-	-	Spring daytime
101	5	711.7	907.2	605	0.057	0.227	303	0.081	0.316	-	-	-	-	Spring nighttime
102	6	21175.8	63.7	19440	0.019	0.255	5693	0.08	0.195	2068	0.173	0.32	Cooking	Background
103	6	47899.3	43.7	105700	0.005	0.431	31930	0.071	0.287	-	-	-	Cooking Boiling	-
104	6	576156	133.6	167500	0.016	0.0754	452300	0.022	0.265	15680	0.147	0.253	Cooking Deep-frying	-
105	6	106510	79.4	14810	0.014	0.0293	150000	0.009	0.184	42580	0.059	0.346	Cooking Pan-frying	-
106	6	45512.8	70.3	29320	0.009	0.182	37080	0.043	0.396	608	0.09	0.19	Cooking Steaming	-
107	6	92013.3	60.9	4172	0.011	0.045	73610	0.027	0.262	27030	0.059	0.354	Cooking Stir-Frying	-
108	6	53267.5	30.9	37020	0.011	0.139	33410	0.034	0.385	6372	0.095	0.199	Cooking Boiling	Start
109	6	49034.3	60.8	170100	0.003	0.5415	30270	0.073	0.276	557	0.358	0.13	Cooking Boiling	Middle
110	6	44051.6	65.4	125900	0.004	0.22	40540	0.076	0.285	13210	0.021	0.209	Cooking Boiling	end
111	6	53148	20.6	38400	0.011	0.143	25930	0.03	0.326	11750	0.09	0.2304	Cooking	Steaming-Start
112	6	45916.8	64.0	31670	0.009	0.19	37010	0.046	0.38	7357	0.091	0.179	Cooking	Steaming-Middle
113	6	43823.7	102	133300	0.004	0.209	42470	0.038	0.43	14290	0.094	0.19	Cooking	Steaming-End
114	7	3884.9	2.7	3813	0.009	0.1205	1486	0.023	0.185	1635	0.073	0.297	-	15:41pm–20:18pm
115	7	9242.8	3.9	2516	0.012	0.161	4446	0.04	0.167	4031	0.061	0.299	-	16:46pm–20:54pm
116	7	5365.4	0.1	28730	0.005	0.201	4733	0.016	0.33	-	-	-	-l	15:21pm–18:21pm
117	7	26367.7	4.5	7828	0.01	0.083	4236	0.016	0.097	20580	0.034	0.314	-	04:00PM-9:10PM
118	7	39750.4	3.7	12520	0.01	0.079	10840	0.015	0.124	26040	0.031	0.301	-	04:00PM-06:15PM
119	7	14192.2	3.2	1536	0.009	0.0645	2672	0.014	0.1172	12690	0.044	0.27	-	06:30PM-09:00PM
120	7	6194.4	0.7	24040	0.007	0.173	1527	0.028	0.146	467	0.107	0.187	-	08:09AM-11:09AM
121	7	2013.6	2.1	6190	0.008	0.143	484	0.048	0.179	336	0.195	0.135	-	08:00AM-08:45AM

122	7	12060.8	2.1	51610	0.007	0.15	3176	0.025	0.123	1591	0.065	0.3	-	09:00AM-09:15AM
123	8	4981.9	8006.4	3622	0.042	0.3013	3200	0.1	0.22	1254	0.189	0.252	Cooking (Kitchen)	Background
124	8	165250	179033	101500	0.027	0.1818	88810	0.026	0.4623	6029	0.129	0.136	Cooking (Kitchen)	10 min
125	8	290237	325187	19780	0.02	0.899	243900	0.028	0.24	69220	0.096	0.281	Cooking (Kitchen)	30 min
126	8	27780.8	35212.4	19830	0.044	0.278	13120	0.043	0.46	3582	0.142	0.206	After cooking (Kitchen)	10 min
127	8	8091.6	12056.8	11710	0.067	0.354	462	0.129	0.130	-	-	-	After cooking (Kitchen)	30min
128	8	6254.0	9578.1	3719	0.035	0.354	895	0.115	0.155	5188	0.093	0.326	Cooking (Livingroom)	Background
129	8	72161.3	88072	1817	0.072	0.1205	61490	0.052	0.396	28510	0.031	0.307	Cooking (Livingroom)	10 min
130	8	81649.9	97573	24370	0.041	0.187	70470	0.041	0.401	7217	0.105	0.185	Cooking (Livingroom)	30 min
131	8	21493.1	28745.6	2663	0.044	0.187	26140	0.059	0.363	388	0.15	0.0969	After cooking (Livingroom)	10 min
132	8	8408.8	12444.9	4990	0.044	0.3483	7589	0.089	0.305	34.5	0.452	0.100	After cooking (Livingroom)	30min
133	9	12469.5	4.5	3423	0.027	0.045	8417	0.04	0.13	3240	0.123	0.1	-	Background
134	9	20310	54.9	83080	0.026	0.164	138300	0.061	0.193	3642	0.176	0.1	Frying food	Cooking period
135	9	20637.9	51.6	3181	0.027	0.0374	23760	0.123	0.182	9917	0.042	0.143	Cigarette Smoldering	Smoking period
136	9	281355	38.6	211600	0.09	0.053	239300	0.02	0.198	24240	0.074	0.285	Cooking soup	Cooking period
137	9	14234	8.9	1516	0.016	0.053	4687	0.024	0.14	10610	0.063	0.27	Kerosene heater	0min
138	9	1000719	18.2	635600	0.009	0.060	857800	0.019	0.19	68530	0.037	0.27	Kerosene heater	20min
139	9	1391605	26.0	972500	0.01	0.057	372400	0.017	0.17	575100	0.03	0.21	Kerosene heater	50min
140	9	716936	40.5	79690	0.017	0.041	394700	0.026	0.12	253000	0.051	0.17	Kerosene heater	120min
141	10	1059.5	0.2	1460	0.07	0.269	271	0.159	0.097	-	-	-	No indoor activities	00:39am
142	10	2297.6	8.2	2532	0.089	0.298	852	0.047	0.123	72.8	0.189	0.0211	Traffic increased	05:00am

143	10	1898.7	4.2	544	0.027	0.11	1327	0.066	0.152	1132	0.149	0.167	Classrooms (occupied)	12:00pm
144	10	6100.2	3.2	1072	0.069	0.3	5420	0.064	0.093	379	0.143	0.086	Only cleaning staff were in the classrooms	16:00pm
145	10	1411.2	9.7	317	0.052	0.146	1879	0.087	0.294	15	0.7	0.146	Cleaning activities	After school hours
146	10	1865.9	5.0	1020	0.041	0.179	1489	0.088	0.301	80.3	0.184	0.1003	Classrooms (occupied)	At school hours
147	10	1392.9	7.3	1616	0.067	0.227	245	0.105	0.398	314	0.179	0.136	Cleaning activities	During classroom after hours
148	10	1779.6	4.5	362	0.033	0.164	2149	0.076	0.297	124	0.185	0.093	Classroom (occupied)	During classroom hours
149	10	1365.7	11.8	1622	0.064	0.2304	480	0.167	0.190	25	0.7	0.161	Cleaning activities	During preschool after hours
150	10	2305.9	3.9	1507	0.041	0.152	355	0.066	0.1003	1076	0.112	0.2552	Classroom (occupied)	During preschool hours
151	11	282.8	2.0	100	0.051	0.447	288	0.078	0.173	15	0.327	0.256	Printer	during working time
152	11	15395.4	1.3	8832	0.0035	0.1003	6098	0.047	0.127	700	0.076	0.2304	Printer	during working time
153	11	81926.1	5.7	21240	0.029	0.1038	48910	0.044	0.139	13100	0.034	0.287	Printer	during working time
154	12	16693.4	187.7	10800	0.031	0.225	10790	0.09	0.274	746	0.594	0.1702	Scrambling egg	Background
155	12	67237.1	135.4	16890	0.024	0.1105	49610	0.027	0.3012	15920	0.126	0.294	Scrambling egg	Start
156	12	163206	236.1	71670	0.03	0.227	130000	0.064	0.328	-	-	-	Scrambling egg	End
157	12	83486.7	74.7	6681	0.026	0.123	82880	0.049	0.32	12030	0.066	0.3	Scrambling egg	Recovery
158	12	48004.4	42.3	2584	0.024	0.0969	30250	0.054	0.27	26400	0.062	0.3	Scrambling egg	30min
159	12	28362.8	91.6	24064	0.049	0.271	13090	0.088	0.342	101	0.543	0.029	Scrambling egg	60 min
160	12	14304.1	252.6	4742	0.035	0.184	13880	0.056	0.42	640	0.737	0.11	Frying chicken	1ST Background
161	12	150654	173.5	148400	0.055	0.324	41670	0.066	0.19	-	-	-	Frying chicken	2ND background

162	12	178100	290.6	227000	0.058	0.298	1226	0.414	0.176	-	-	-	Frying chicken	Start
163	12	230332	262.3	25680	0.025	0.14	142000	0.052	0.2095	109100	0.07	0.32	Frying chicken	End
164	12	157283	617.5	8525	0.032	0.136	216700	0.085	0.28	35110	0.1	0.3	Frying chicken	Recovery
165	12	40961.3	263.5	4664	0.034	0.149	74760	0.103	0.235	1906	0.378	0.164	Frying chicken	30min
166	12	19824.6	115.9	3536	0.032	0.176	37970	0.111	0.23	1000	0.3	0.11	Frying chicken	60min
167	12	12666.4	29.4	10270	0.04	0.248	7395	0.115	0.24	190	0.344	0.065	Cooking soup	Background
168	12	23679.6	37.3	17530	0.03	0.206	539	0.087	0.072	10930	0.093	0.294	Cooking soup	Start
169	12	94864.5	45.3	98320	0.026	0.243	689	0.349	0.152	5892	0.13	0.182	Cooking soup	Aerosol
170	12	73954.8	40.6	74280	0.027	0.238	775	0.091	0.056	6623	0.129	0.26	Cooking soup	End
171	12	70741.9	36.2	50280	0.036	0.255	35790	0.018	0.477	1588	0.178	0.155	Cooking soup	Recovery
172	12	45569.5	37.2	42830	0.033	0.22	8351	0.1098	0.265	29.9	0.616	0.037	Cooking soup	30min
173	12	36576.1	23.2	30100	0.037	0.222	7160	0.04	0.3	5000	0.144	0.19	Cooking soup	60min
174	13	0.2	0.9	41000000	0.27	0.16	70000	1.6	0.33	-	-	-	School library (occupied)	five most pollutant days
175	13	0.02	0.3	14000000	0.28	0.15	80000	1	0.39	-	-	-	School library (occupied)	five least pollutant days
176	14	9785.0	16.8	8500	0.038	0.252	4000	0.11	0.26	5	0.35	0.46	Typical room with an indoor source	Continuous 18 months
177	14	16619.1	6.7	100	0.002	0.699	20000	0.028	0.36	2	0.8	0.447	Typical room with an indoor source	Continuous 18 months
178	14	2308.9	3.0	1000	0.017	0.47	2500	0.08	0.23	3	0.032	0.699	-	Continuous 18 months
179	14	2193.6	2.6	1800	0.01	0.477	2000	0.08	0.243	5	0.03	0.69	-	Continuous 18 months
180	15	178330	636.5	1000700	0.054	0.42	126300	0.061	0.22	18140	0.19	0.18	Cooking Bacon with gas stove Max power	10min
181	15	38178.7	49.6	33980	0.025	0.27	15420	0.108	0.25	250	0.287	0.097	Cooking Bacon with gas stove Min power	10min

182	15	100190	10.8	108700	0.01	0.307	451800	0.022	0.149	3944	0.126	0.19	Grilling Food	8min
183	15	246051	1784	193100	0.028	0.328	75850	0.049	0.176	13940	0.133	0.342	Grilling cheese with gas stove Max power	10min
184	15	297379	299.1	160700	0.008	0.146	305000	0.049	0.3	10040	0.231	0.176	Cooking Bacon with gas stove max power	10min
185	15	239938	76.9	229200	0.021	0.318	49670	0.042	0.164	3781	0.163	0.287	Cooking eggplant with gas stove max power	10min
186	15	324355	585	170900	0.019	0.37	194000	0.047	0.182	239900	0.131	0.361	Cooking wurstel with gas stove max power	10min
187	15	322454	117.8	185500	0.028	0.378	190100	0.055	0.201	2043	0.189	0.11	Cooking with sunflower oil	8min
188	15	353403	292.4	150800	0.01	0.435	340500	0.059	0.25	8038	0.25	0.156	Cooking with olive oil	8min
189	15	341110	93.1	68300	0.02	0.173	305500	0.053	0.232	9624	0.098	0.08	Cooking with Peanut oil	8min
190	16	8047.2	63.9	2274	0.042	0.32	8250	0.081	0.334	2151	0.102	0.376	Cooking	Background
191	16	7953.3	866.5	2485	0.048	0.255	14030	0.118	0.285	12200	0.363	0.1987	Frying Chicken	Cooking time is 2 min15s
192	16	74020.7	1480	6000	0.028	0.0934	229500	0.139	0.19	43500	0.15	0.3	Frying beef	Cooking time is 5min
193	16	9311.2	963.6	2613	0.034	0.152	10000	0.087	0.27	9000	0.28	0.32	Cooking with hot oil	Cooking time is 5min
194	16	7880.8	709.4	1915	0.034	0.198	15360	0.124	0.298	11310	0.32	0.214	Frying pork	Cooking time is 5min
195	16	8277.3	218	3456	0.036	0.207	9250	0.1	0.262	4016	0.268	0.257	Cooking chicken at 200℃	Cooking time is 2 min15s
196	16	7594.9	957.2	497	0.034	0.0969	17780	0.124	0.346	5073	0.41	0.23	Cooking chicken220℃	Cooking time is 2 min15s
197	16	7239.6	1025	20040	0.14	0.38	732	0.12	0.0934	6829	0.362	0.173	Cooking chicken240℃	Cooking time is 2 min15s

198	16	10035.3	478	2821	0.035	0.181	21550	0.141	0.342	435	0.352	0.0607	Cooking pork 220 ℃	Cooking time is 5min
199	16	7824.2	691.6	5499	0.051	0.262	8165	0.123	0.2148	14880	0.3	0.22	Cooking pork 240 ℃	Cooking time is 5min
200	16	9885.5	335.6	1567	0.031	0.156	8347	0.074	0.24	12630	0.185	0.296	Cooking steak 210℃	Cooking time is 5min
201	16	9118.2	916.7	3013	0.038	0.164	14940	0.116	0.235	9803	0.344	0.248	Cooking steak 240℃	Cooking time is 5min

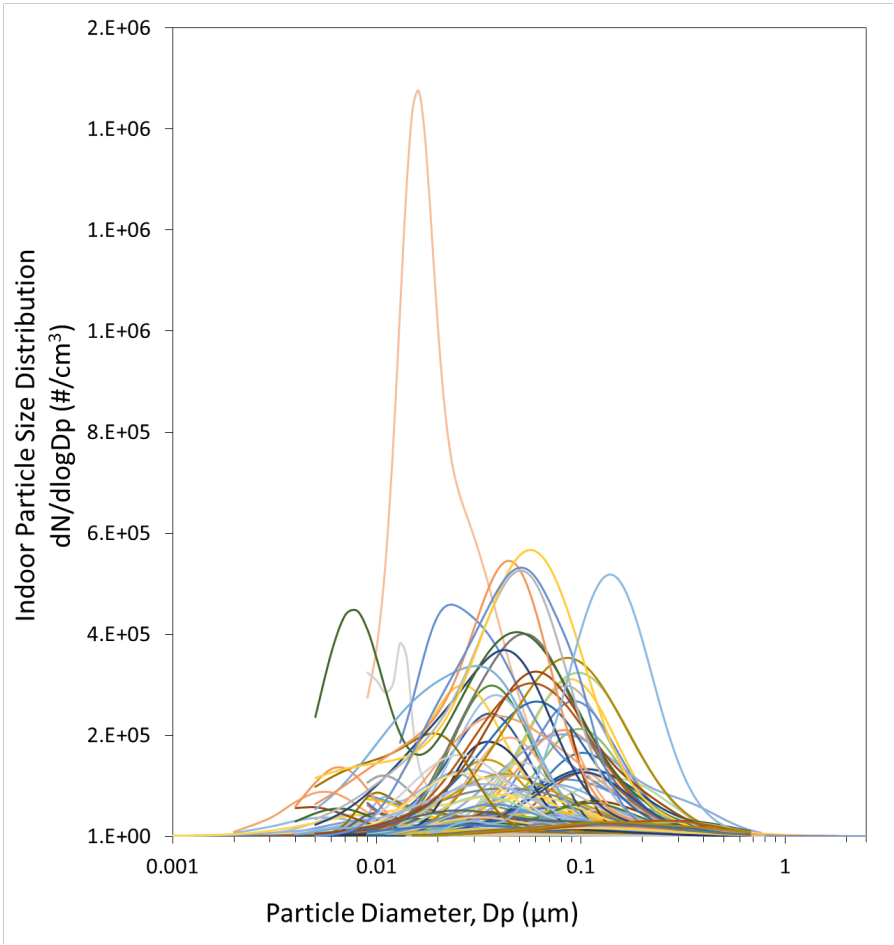

Figure C.1. Collection of 201 particle size distributions from 16 studies in the existing literature (covering only those size ranges measured in the original reference)

Appendix D. Estimates of filter removal efficiency for indoor UFPs and $PM_{2.5}$

Table D.1. Summary of distributions of UFP removal efficiency (values in %) for 201 indoor PSDs and 50 commercially available HVAC filters

UFP	Mean	STD	Coefficient of Variation	1%	5%	10%	25%	50%	75%	90%	95%	99%
MERV < 4,1" (Flanders)	47.9	2.1	0.04	42.7	44.1	45.2	46.5	47.9	49.3	50.5	51.1	51.8
MERV 6,1" (AirFilterBuy)	47.1	1.6	0.03	44.7	45.0	45.4	45.9	46.7	47.9	49.8	50.5	51.5
MERV 6,2" (AirFilterBuy)	70.0	2.7	0.04	64.7	65.8	66.8	68.0	69.6	71.5	73.6	75.4	76.4
MERV 7,1" (AirRelief Tex-air)	27.5	3.0	0.11	21.6	22.8	23.9	25.2	27.0	29.1	31.6	33.7	34.8
MERV 7,2" (AirRelief Tex-air)	36.3	2.3	0.06	31.7	32.7	33.6	34.6	36.1	37.7	39.4	41.0	41.8
MERV 7,4" (AirRelief Tex-air)	31.3	2.5	0.08	27.1	27.9	28.6	29.4	30.8	32.5	35.2	36.4	37.8
MERV 8,1" (WEB-ECO)	42.4	0.7	0.02	40.6	41.2	41.5	42.1	42.5	42.9	43.3	43.5	43.7
MERV 8,1" (Airguard)	19.7	2.4	0.12	15.4	16.3	17.0	17.9	19.3	20.9	23.3	24.7	25.9
MERV 8,1" (Airguard)	19.4	4.9	0.25	9.7	11.8	13.6	15.7	18.7	22.2	25.9	29.2	31.0
MERV 8,2" (Airguard)	17.4	2.0	0.12	13.9	14.6	15.2	15.9	17.0	18.4	20.7	21.6	22.8
MERV 8,2" (Airguard)	22.1	6.6	0.30	11.3	13.2	14.9	17.2	20.8	25.3	32.9	35.9	40.0
MERV 8,4" (Airguard)	23.5	6.0	0.25	13.2	15.2	16.9	19.0	22.4	26.5	33.2	35.8	39.4
MERV 8,4" (Airguard)	37.6	6.0	0.16	26.8	28.9	30.7	33.1	36.5	40.6	46.8	50.0	53.1
MERV 8,2" (Flanders)	51.8	3.2	0.06	44.1	46.2	47.8	49.6	51.9	54.0	55.8	56.9	57.9
MERV 8,1" (AirRelief Tex-air)	33.4	5.4	0.16	23.9	25.7	27.3	29.3	32.4	36.1	41.6	44.5	47.3
MERV 8,2" (AirRelief Tex-air)	71.6	1.0	0.01	70.8	71.0	71.0	71.1	71.2	71.8	72.9	74.3	75.3
MERV 8,4" (AirRelief Tex-air)	70.4	1.3	0.02	68.2	68.7	69.1	69.5	70.1	70.9	72.6	73.1	74.3
MERV 8,2" (QualityFilters ODORBAN)	49.0	2.0	0.04	45.9	46.6	47.0	47.6	48.5	49.9	52.4	53.2	54.9
MERV 8,2" (QualityFilters)	61.1	5.4	0.09	50.8	53.0	54.9	57.1	60.3	63.9	68.6	72.1	74.3
MERV 11,1" (Airguard)	56.2	1.3	0.02	53.8	54.2	54.6	55.2	55.9	56.8	58.0	58.9	59.4
MERV 11,2" (Airguard)	43.3	2.0	0.05	36.7	38.1	39.9	42.6	44.0	44.7	44.9	45.0	45.0
MERV 11,4" (Airguard)	82.4	0.6	0.01	81.2	81.5	81.7	82.0	82.5	82.9	83.1	83.4	83.5
MERV 11,2" (Flanders)	63.2	1.2	0.02	61.5	61.9	62.2	62.5	62.9	63.5	64.4	66.1	67.6
MERV 11,1" (AirRelief Tex-air)	46.5	3.3	0.07	38.4	40.7	42.4	44.3	46.7	48.7	50.5	51.3	52.4
MERV 11,2" (AirRelief Tex-air)	55.8	2.7	0.05	49.7	51.2	52.5	54.0	55.7	57.6	59.3	60.4	61.2
MERV 11,4" (AirRelief Tex-air)	41.7	0.9	0.02	40.4	40.8	40.9	41.1	41.3	42.0	43.1	43.6	44.1
MERV 11,2" (QualityFilters)	72.1	1.7	0.02	69.6	70.1	70.5	70.9	71.7	72.8	75.0	75.7	77.2

MERV 13,1" (Airguard)	72.5	4.2	0.06	65.3	66.6	67.8	69.3	71.7	74.6	79.0	81.1	83.3
MERV 13,2" (Airguard)	65.3	3.3	0.05	62.0	62.3	62.4	62.9	64.1	66.6	71.2	73.0	75.8
MERV 13,4" (Airguard)	71.4	1.4	0.02	69.0	69.3	69.8	70.5	71.3	72.2	73.4	73.9	75.2
MERV 13,2" (Flanders)	55.2	1.0	0.02	53.0	53.5	54.0	54.5	55.2	55.9	56.4	56.8	57.1
MERV 13,1" (AirRelief Tex-air)	46.4	8.7	0.19	32.9	35.0	37.0	39.8	44.5	50.6	60.7	64.7	70.1
MERV 13,2" (AirRelief Tex-air)	64.7	4.9	0.08	56.5	57.9	59.2	61.0	63.7	67.1	72.5	74.8	77.6
MERV 13,4" (AirRelief Tex-air)	43.8	3.5	0.08	39.3	39.6	40.2	41.1	42.9	45.4	49.9	51.6	54.1
MERV 13,2" (QualityFilters)	71.5	1.1	0.02	69.5	70.1	70.4	70.8	71.1	72.1	73.3	73.8	74.5
MERV 16,5" (Healthy Solutions)	97.3	0.1	0.00	97.1	97.1	97.1	97.2	97.3	97.4	97.5	97.6	97.7
MPR 300,1" (3M)	39.8	1.5	0.04	34.8	36.3	38.1	39.5	40.2	40.7	41.0	41.5	42.0
MPR 300,1" (3M)	25.2	2.1	0.08	21.2	22.0	22.8	23.7	25.0	26.4	28.0	29.5	30.2
MPR 600,1" (3M)	49.1	4.4	0.09	42.9	43.7	44.6	45.8	48.0	51.2	56.7	58.8	61.8
MPR 1000,1" (3M)	48.8	1.3	0.03	47.5	47.6	47.7	47.9	48.4	49.3	51.0	51.8	52.7
MPR 1000,4" (3M)	35.5	1.2	0.03	34.3	34.6	34.7	34.9	35.1	35.5	36.7	38.7	40.0
MPR 1550,4" (3M)	24.1	1.9	0.08	22.3	22.5	22.8	23.2	23.8	24.5	25.4	26.0	26.4
MPR 1900,1" (3M)	11.2	5.1	0.45	3.8	4.9	5.9	7.4	10.0	13.6	19.9	22.3	25.7
MPR 2200,1" (3M)	53.3	1.4	0.03	48.9	50.3	51.5	52.8	53.6	54.2	54.6	55.0	55.6
MPR 2800,1" (3M)	52.9	0.1	0.00	52.7	52.8	52.8	52.9	52.9	53.0	53.0	53.1	53.2
FPR 4,1" (Rheem)	59.7	0.8	0.01	58.8	58.8	58.9	59.1	59.5	60.0	61.0	61.3	61.9
FPR 7,1" (Honeywell)	56.0	0.8	0.01	55.1	55.3	55.3	55.4	55.6	56.2	57.3	58.0	58.7
FPR 9,1" (Honeywell)	51.9	1.0	0.02	50.1	50.5	50.8	51.3	51.7	52.4	53.2	54.1	55.3
FPR 10,1" (Honeywell)	71.0	2.0	0.03	67.3	67.7	68.4	69.8	70.9	72.3	73.8	74.8	75.9
FPR 10,4" (Honeywell)	66.2	0.8	0.01	64.7	65.1	65.3	65.6	66.0	66.5	67.3	67.5	68.1

Table D.2. Summary of distributions of $PM_{2.5}$ removal efficiency (values in %) for 201 indoor PSDs and 50 commercially available HVAC filters

$PM_{2.5}$	Mean	STD	Coefficient of Variation	1%	5%	10%	25%	50%	75%	90%	95%	99%
MERV < 4,1" (Flanders)	23.0	6.1	0.26	15.0	15.6	16.2	18.4	21.9	25.8	29.5	35.6	42.4
MERV 6,1" (AirFilterBuy)	60.2	8.2	0.14	46.0	47.5	50.9	54.6	58.9	65.9	71.5	74.1	80.1
MERV 6,2" (AirFilterBuy)	66.5	4.6	0.07	60.9	61.5	61.9	63.3	65.0	69.3	73.2	74.7	80.0
MERV 7,1" (AirRelief Tex-air)	30.8	8.7	0.28	20.4	21.0	21.8	24.4	28.3	36.6	43.5	46.1	55.3
MERV 7,2" (AirRelief Tex-air)	36.6	6.3	0.17	29.5	29.9	30.3	32.3	34.5	40.6	45.7	47.7	55.1
MERV 7,4" (AirRelief Tex-air)	37.9	7.6	0.20	27.4	28.8	29.5	32.4	36.1	43.1	48.8	51.2	58.5
MERV 8,1" (WEB-ECO)	42.4	5.1	0.12	37.0	37.5	37.9	38.9	40.6	45.1	49.7	51.3	58.2
MERV 8,1" (Airguard)	21.9	6.0	0.27	14.8	15.3	15.7	17.6	20.1	25.9	30.5	32.4	39.2
MERV 8,1" (Airguard)	26.4	13.9	0.53	8.1	10.0	10.9	15.7	22.9	36.0	46.6	51.1	63.7
MERV 8,2" (Airguard)	19.7	5.0	0.25	13.7	14.3	14.5	16.1	18.3	23.0	26.8	28.4	33.9
MERV 8,2" (Airguard)	19.2	7.4	0.39	9.8	10.5	11.4	13.7	17.0	24.1	30.0	32.2	39.9
MERV 8,4" (Airguard)	13.6	4.8	0.35	7.9	8.5	9.0	10.2	11.9	16.2	20.4	21.9	28.1
MERV 8,4" (Airguard)	25.3	5.0	0.20	19.6	20.2	20.7	21.7	23.5	28.2	32.1	33.7	40.4
MERV 8,2" (Flanders)	20.3	6.3	0.31	13.0	14.3	15.0	16.4	18.4	22.2	27.9	34.0	43.8
MERV 8,1" (AirRelief Tex-air)	37.0	10.4	0.28	23.0	24.7	25.4	29.0	34.4	44.1	52.0	55.4	64.9
MERV 8,2" (AirRelief Tex-air)	48.8	7.8	0.16	36.5	39.5	40.4	43.4	46.7	53.2	58.8	65.9	70.1
MERV 8,4" (AirRelief Tex-air)	51.1	5.6	0.11	42.6	44.6	44.9	46.9	49.5	54.2	57.8	63.5	67.5
MERV 8,2" (QualityFilters ODORBAN)	42.5	3.8	0.09	38.7	39.1	39.3	40.2	41.1	43.9	46.8	47.7	55.2
MERV 8,2" (QualityFilters)	48.9	5.6	0.11	42.4	43.1	43.7	44.9	46.9	52.1	56.6	58.4	65.5
MERV 11,1" (Airguard)	65.3	6.8	0.10	54.5	55.7	57.4	60.4	63.9	70.0	74.8	77.1	82.6
MERV 11,2" (Airguard)	50.7	5.3	0.10	44.5	44.9	45.2	47.0	49.2	54.2	58.3	60.0	66.0
MERV 11,4" (Airguard)	70.2	5.3	0.08	61.7	62.7	63.4	65.7	69.6	73.6	77.1	81.0	82.7
MERV 11,2" (Flanders)	49.0	5.7	0.12	39.3	41.9	42.6	44.8	47.5	52.5	56.8	60.8	63.1
MERV 11,1" (AirRelief Tex-air)	29.6	7.4	0.25	21.7	22.6	23.1	24.1	26.7	33.5	39.1	41.7	52.3
MERV 11,2" (AirRelief Tex-air)	42.0	4.3	0.10	37.4	37.9	38.1	39.0	40.5	43.9	47.3	50.3	54.8
MERV 11,4" (AirRelief Tex-air)	38.6	2.6	0.07	35.3	35.6	35.9	36.9	38.4	39.7	41.1	41.8	47.0
MERV 11,2" (QualityFilters)	55.7	4.4	0.08	49.4	50.6	51.6	52.8	54.4	57.5	60.9	65.4	70.1
MERV 13,1" (Airguard)	72.5	5.2	0.07	64.9	66.0	66.5	68.6	71.3	76.2	80.0	81.8	86.0

MERV 13,2" (Airguard)	80.5	6.0	0.07	63.6	68.3	73.9	77.2	80.8	84.7	88.0	89.3	91.6
MERV 13,4" (Airguard)	74.6	1.9	0.02	72.5	73.0	73.1	73.6	74.3	75.0	76.0	76.7	81.0
MERV 13,2" (Flanders)	60.5	6.1	0.10	52.7	53.6	53.9	56.0	59.0	64.6	69.3	71.2	77.1
MERV 13,1" (AirRelief Tex-air)	53.4	10.0	0.19	35.5	38.5	41.0	46.5	52.3	60.4	67.2	70.4	76.6
MERV 13,2" (AirRelief Tex-air)	65.1	6.0	0.09	56.2	57.7	58.1	60.6	63.7	69.3	73.6	75.6	80.6
MERV 13,4" (AirRelief Tex-air)	63.7	10.6	0.17	41.5	44.6	51.3	56.8	62.7	71.1	77.9	81.0	86.8
MERV 13,2" (QualityFilters)	71.4	2.5	0.03	66.7	67.8	68.7	69.8	70.9	72.8	74.7	75.3	76.7
MERV 16,5" (Healthy Solutions)	99.9	1.1	0.01	99.5	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MPR 300,1" (3M)	37.0	6.4	0.17	30.5	31.0	31.4	32.5	34.7	39.7	45.8	47.9	57.1
MPR 300,1" (3M)	29.8	7.6	0.25	20.6	21.5	21.8	24.3	27.7	34.9	40.8	43.1	51.2
MPR 600,1" (3M)	61.4	8.8	0.14	45.4	47.5	50.9	55.3	60.3	67.5	73.4	76.2	81.9
MPR 1000,1" (3M)	65.9	8.3	0.13	48.3	51.4	56.5	60.6	65.0	71.6	77.1	79.6	84.8
MPR 1000,4" (3M)	29.8	3.3	0.11	25.7	26.4	26.7	27.7	29.2	30.9	33.3	34.5	39.8
MPR 1550,4" (3M)	33.2	7.0	0.21	22.9	23.9	25.5	28.3	31.6	37.9	43.1	45.3	52.0
MPR 1900,1" (3M)	16.4	7.7	0.47	4.8	6.5	7.6	10.9	14.9	21.7	27.3	29.8	36.6
MPR 2200,1" (3M)	49.6	6.8	0.14	42.4	43.1	43.5	44.8	47.2	52.9	59.3	61.4	70.5
MPR 2800,1" (3M)	69.5	7.8	0.11	53.5	56.1	60.5	64.3	68.6	74.9	80.1	82.5	87.5
FPR 4,1" (Rheem)	66.1	4.0	0.06	59.2	60.0	61.7	63.4	65.4	68.8	71.6	72.8	76.3
FPR 7,1" (Honeywell)	68.4	5.3	0.08	56.3	58.9	62.5	65.1	67.9	72.0	75.4	76.9	80.3
FPR 9,1" (Honeywell)	57.1	1.4	0.02	53.1	55.5	56.3	56.7	56.9	57.4	58.5	58.8	61.2
FPR 10,1" (Honeywell)	75.7	1.0	0.01	73.9	74.4	74.8	75.2	75.6	76.1	76.8	76.9	77.9
FPR 10,4" (Honeywell)	81.6	4.6	0.06	68.4	72.8	76.7	79.2	81.8	84.8	87.7	88.3	90.2

Table D.3. Significance testing of total UFP removal efficiency compared between 50 measured filters using Wilcoxon rank-sum (Mann–Whitney) test

	MERV <4	MERV 6		MERV 7			MERV 8													MERV 11									MERV 13									MERV 16	FPR					MPR								
																																							4	7	9	10		300	600	1000	1550	1900	2200	2800	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	*	*	*	*	*	*	*	n.s.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	*	*	*	*	*	*	*	n.s.	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	*	*	*	*	n.s.	*	*	*	*	*	n.s.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

28	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	n.s.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	n.s.	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	n.s.	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	n.s.	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-
40	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	-	-	-	-	-	-	-	-	-	-	-	-
41	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-
42	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-
43	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-
44	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-
45	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-
46	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-
47	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-
48	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-
49	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	n.s.	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-
50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-

*$p < 0.001$

n.s. = not significant ($p > 0.001$)

Table D.4. Significance testing of total $PM_{2.5}$ removal efficiency compared between 50 measured filters using Wilcoxon rank-sum (Mann–Whitney) test

	MERV<4	MERV 6		MERV 7			MERV 8													MERV 11								MERV 13								MERV 16	FPR				MPR							
																																					4	7	9	10	300	600	1000	1550	1900	2200	2800
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	*	*	*	*	n.s.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	n.s.	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	n.s.	*	*	*	*	*	*	n.s.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	*	*	*	*	*	*	*	*	*	n.s.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	*	*	*	*	*	*	*	*	*	n.s.	n.s.	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	*	*	*	*	n.s.	n.s.	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	n.s.	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

27	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	n.s.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	*	*	*	*	n.s.	n.s.	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-
39	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-
40	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	n.s.	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-
41	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	n.s.	n.s.	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-
42	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	-	-	-	-	-	-	-	-	-	-
43	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-
44	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-
45	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	n.s.	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-
46	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-
47	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	n.s.	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	-	-	-	-
48	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	n.s.	*	*	-	-	-
49	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-
50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-

*$p < 0.001$

n.s. = not significant ($p > 0.001$)

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