

DaVita White Paper:

Design and Installation of UV Air Purifying Systems

in the DaVita Dialysis Centers

By

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For

Infection Prevention technologies, Inc.

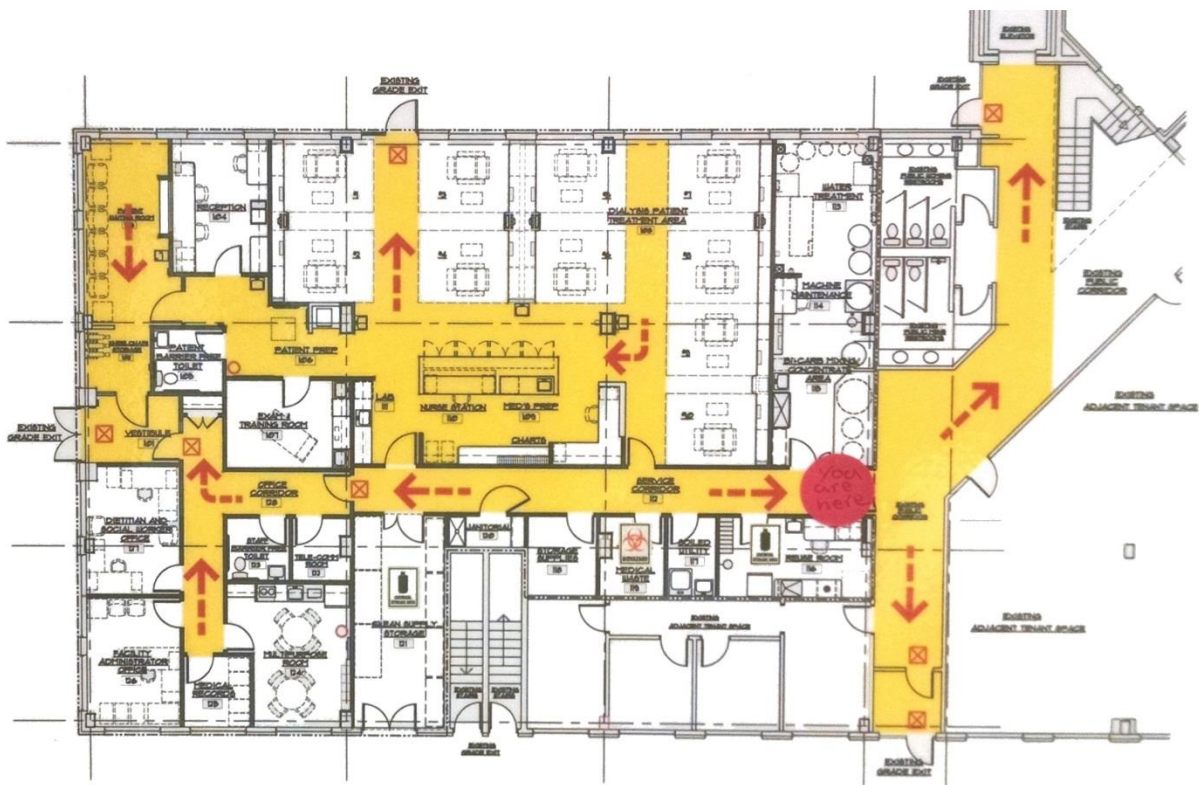
Executive Summary

The DaVita Clinic in Kalamazoo (West #2287) is used as a model for the evaluation of installation of a UV air disinfection system for other DaVita locations. The planned retrofit consists of six UV400 units from UV Flu Technology, Inc. These units have been previously evaluated to produce a UV Dose of 41 J/m². It is the intent of this system to reduce or eliminate potential contamination hazards produced by pathogens and fungal spores that hail from the ambient or indoor environment and may contaminate the dialysis machines. The three most common fungi of concern in healthcare are *Aspergillus* species (spp.), *Histoplasma capsulatum*, and *Cryptococcus neoformans*. The DaVita clinic is modeled as a volume with internal supply air and 15% outdoor air. Analysis of all three microbial groups, bacteria, viruses, and fungi indicate high removal rates are possible for all types of pathogens. Analysis of the three subject fungal spores indicate that airborne concentrations of each of them can be reduced to less than 10 cfu/m³ within five hours, and that this level of cleanliness can be maintained indefinitely. This level of air cleanliness would be at least equal to that of typical hospital environments where measured fungi levels are often about 50 cfu/m³ or higher. The application of the UV400 units to the clinic should therefore be highly effective at eliminating potential health hazards and equipment contamination concerns.

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The DaVita Dialysis Clinics provide renal dialysis on an outpatient basis and are located in major cities across the USA. There are some 300 clinics across the USA and clinics may be as large as 30,000 ft² with as many as 25 dialysis machines each. Each clinic provides services and access five days a week. Some 80% of patients are diabetics. Figure 1 shows a layout of the facility in Kalamazoo, which has ten dialysis machines. Some mold problems have been reported and it is the purpose of this report to evaluate a retrofit of UV air disinfection units to the clinics to eliminate any health hazards to patients and staff posed by mold contamination. The Kalamazoo facility is used as a model for sizing systems that will be installed at all clinics.



The approximate dimensions of the dialysis area in the clinic are 30' width, 50' length, and 8' height. The overall dimensions of the facility, including the surrounding offices and rooms, is approximately 40' width, 60' length, and 8' height. There are approximately 22 supply and exhaust air registers placed around the ceiling. The overall square footage is about 2400 ft². Based on typical air delivery rates for the square footage the total airflow would be about 2640 cfm. The total outdoor air is assumed to be a typical 15%, or about 400 cfm.

The UV400 Air Disinfection Unit

The UV400 Portable Air Purification Unit employs three LP mercury lamps that are each rated for 24 W of UV output. The unit has a total airflow of 210 cfm that passes through a TiO₂ photocatalyst cartridge and a carbon-treated capture screen that removes large particles. The UV400 produces a UV Dose of 41 J/m². Performance of the unit has previously been evaluated by the author (Kowalski 2013). Proposed locations for the six UV400 units are shown in the schematic diagram in Figure 2. Units should be spaced around the room and near the dialysis machines.

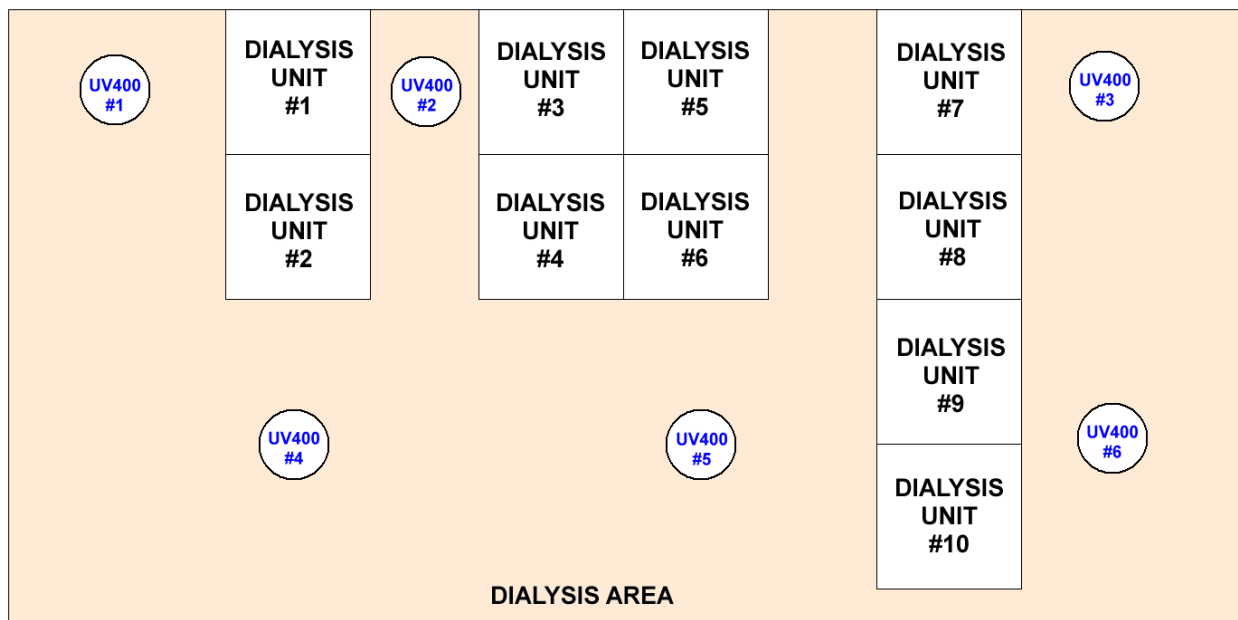


Figure 2: Schematic layout of the six UV400 units in the DaVita Kalamazoo Dialysis Clinic.

The placement of the UV400 units in the layout in Figure 2 are not critical to the analysis and are merely indicative of the location of the units near the clusters of dialysis machines. Ultimately all the air in the clinic will be mixed and the placement of the units is somewhat arbitrary, and may be dependent on available space and power outlets.

Predicted Performance of the UV400 in the DaVita Clinic

The design plan is to add six model UV4000 air disinfection units to each clinic, with four placed in the corners and two placed along the long walls. The combined total airflow through these six units is 1260 cfm and the UV Dose remains the same for all six units combined at 41 J/m². Table 1 summarizes the input data for the model including the relevant design data for the UV400 unit. Table 1 also shows the assumed concentrations of microbes initially in the indoor air and in the outdoor air. It is necessary to assume high indoor concentrations initially so as to evaluate how well these concentrations are reduced over time.

Table 1: Input Data for DaVita Clinic Model

Viratech UV 400 (Six units)	UV Dose	41	J/m ²
	Airflow	35.67942	m ³ /min
	Airflow	1260	cfm
	ACH	3.9375	
Model Room	Floor Area	2400	ft ²
	Height	8	ft
	Volume	19200	ft ³
	Volume	47.6	m ³
	Total Airflow	2640	cfm
	Total Airflow	74.75688	m ³ /min
	OA %	15	
	OA Flowrate	396	cfm
	OA Flowrate	18.68922	m ³ /min
	ACH	8.25	
	OA ACH	1.2	
Indoor Microbes (Initial Concentration)	Bacteria	1000	cfu/m ³
	Viruses	10,000	cfu/m ³
	Fungi	1000	cfu/m ³
Outdoor Microbes	Bacteria	100	cfu/m ³
	Viruses	0	cfu/m ³
	Fungi	600	cfu/m ³
Average k Value	Bacteria	0.1768	m ² /J
	Viruses	0.0742	m ² /J
	Fungi	0.0109	m ² /J
Average Kill Rate (UV 400 Single Pass)	Bacteria	99.9	%
	Viruses	95.2	%
	Fungi	36.1	%

The model of the DaVita clinic will evaluate the airborne concentrations minute-by-minute as the air is disinfected starting from Time = 0. The air inside the clinic is assumed to be completely mixed and this is a reasonable assumption. The removal rates or kill rates per minute of the UV400 are shown in Table 2 based upon the average kill rates for the indicated group, virus, bacteria, and fungi. These values have been averaged from an extensive database of UV rate constants (Kowalski 2009).

Table 2: UV 400 Average Microbial Kill Rates

Parameter	Virus	Bacteria	Fungi
UV Rate Constant k, m ² /J	0.0742371	0.17683104	0.0109219
Kill Rate per minute	0.95234278	0.99928988	0.36096625

The model begins with assumed concentrations of 1000 cfu/m³ of bacteria, 10,000 pfu/m³ of viruses, and 1000 cfu/m³ of fungi. The room concentrations of each of these microbial groups are computed and then the number of microbes removed by the UV400 is computed each minute. Also computed is the number of microbes removed by the outside air flowrate and the number of microbes added by the outside air intake (15% OA). The tabulated analysis for the first 300 minutes (5 hours) is shown in Appendix A. Figure 3 shows the results graphically. It can be observed that the system achieves a steady state at about 3 hours. Both the fungi and the bacteria decrease to a level that is limited by the concentrations of microbes in the outdoor air. The viruses, which do not exist in outdoor air are reduced to near-zero after about 2 hours. The final total microbial concentration in the room is 17 cfu/m³, which is lower than any typical indoor concentrations.

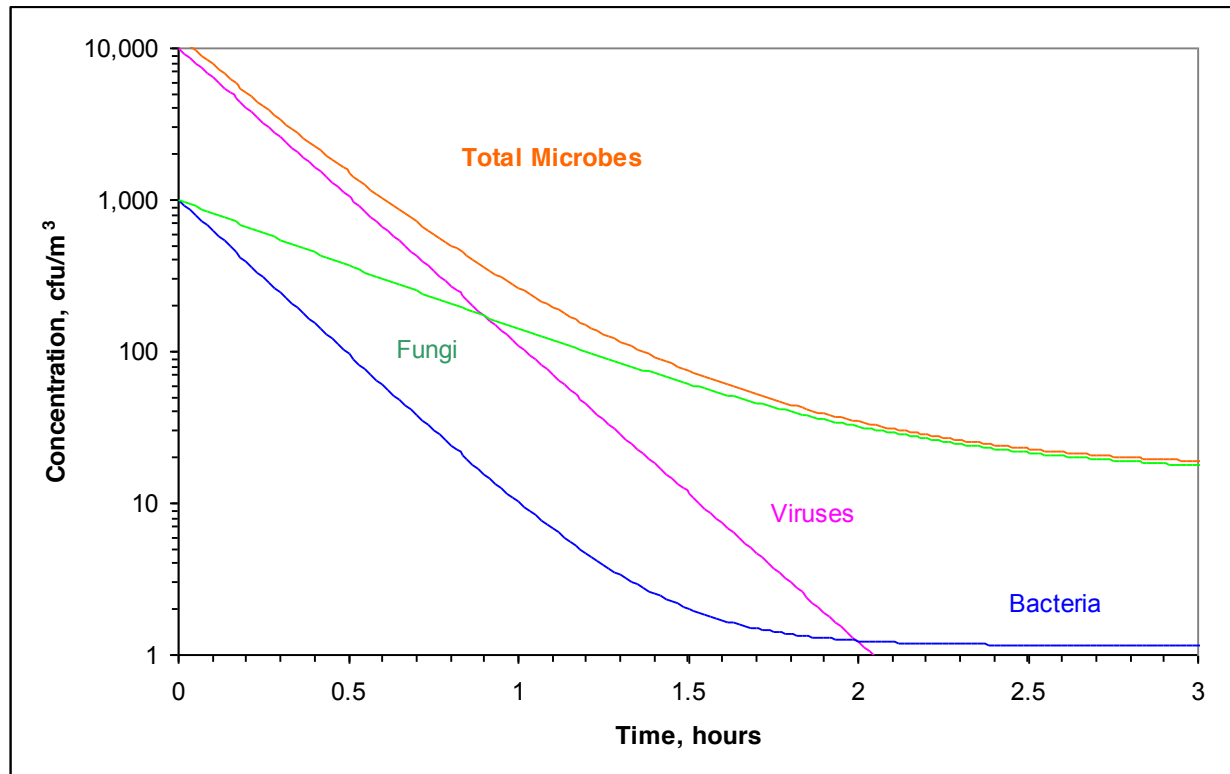


Figure 3: Reduction of airborne concentrations of microbes in the model DaVita clinic.

All three microbial groups have been considered and removal rates are high for all three. The microbes of greatest interest, per DaVita, are the fungi or fungal spores. Some focus on fungal spores is warranted and specific fungal spores are selected here for further analysis.

The most common fungal spores that turn up in hospital settings include *Aspergillus spp.*, *Histoplasma capsulatum*, and *Cryptococcus neoformans*. Other fungi that appear in nosocomial settings include *Blastomyces dermatitidis*, *Coccidioides immitis*, *Mucor plumbeus*, *Pneumocystis carinii*, and *Rhizopus stolonifer*, also these latter fungi are relatively rare. These fungi are tabulated in Table 3 in order of prevalence along with their basic properties.

Table 3: Most Common Fungal Spores in Hospitals

Fungal spore	Prevalence	Disease	Diameter μm	UV k m^2/J
<i>Aspergillus spp.</i>	Common	aspergillosis, alveolitis, asthma	3.354	0.0023
<i>Histoplasma capsulatum</i>	Common	Histoplasmosis, fever, malaise	2.55	0.0247
<i>Cryptococcus neoformans</i>	Common	Cryptococcosis, cryptococcal meningitis	4.899	0.0167
<i>Blastomyces dermatitidis</i>	Rare	blastomycosis, Gilchrist's Disease	11	0.0247
<i>Coccidioides immitis</i>	Rare	Coccidioiomycosis, Valley Fever	3.464	unknown
<i>Mucor plumbeus</i>	Rare	Mucormycosis, rhinitis	7.071	0.0135
<i>Pneumocystis carinii</i>	Rare	Pneumocystosis	2	unknown
<i>Rhizopus stolonifer</i>	Rare	Zygomycosis, allergic reactions	6.928	0.0086

The first three fungal spores will be used in a separate analysis to determine how fast their concentrations are reduced in the DaVita clinic model. All parameters are the same as in the previous analysis except that the initial room concentrations of fungal spores inside the clinic will be assumed to be 1000 cfu/m^3 of each fungi, and the outdoor concentrations will be assumed to be 100 cfu/m^3 for each of the three fungal spores.

The results for the analysis of the fungal spores are tabulated in Appendix B. Figure 3 illustrates the decay of the airborne concentrations of the fungal spores over time, for five hours until a steady state is achieved. The final total concentration after 5 hours is 1.21 cfu/m^3 for *Aspergillus*, 1.16 cfu/m^3 for *Histoplasma*, and 2.65 cfu/m^3 for *Cryptococcus*. These levels are well below normal indoor levels for fungi in hospital environments which can range from $10\text{-}100 \text{ cfu/m}^3$ (Kowalski 2012). Figure 4 illustrates the reductions in airborne concentrations over time for the three fungal spores. This analysis indicates the UV400 units will be effective at reducing airborne concentrations to the minimum possible level after about 5 hours of operation, and that this level of air cleanliness will be maintained indefinitely.

It may be slightly non-conservative to use single stage decay curves to compute the UV survival of these fungal spores and so an additional analysis is performed following to evaluate the effects of two stage decay curves on the overall airborne concentrations in the clinic.

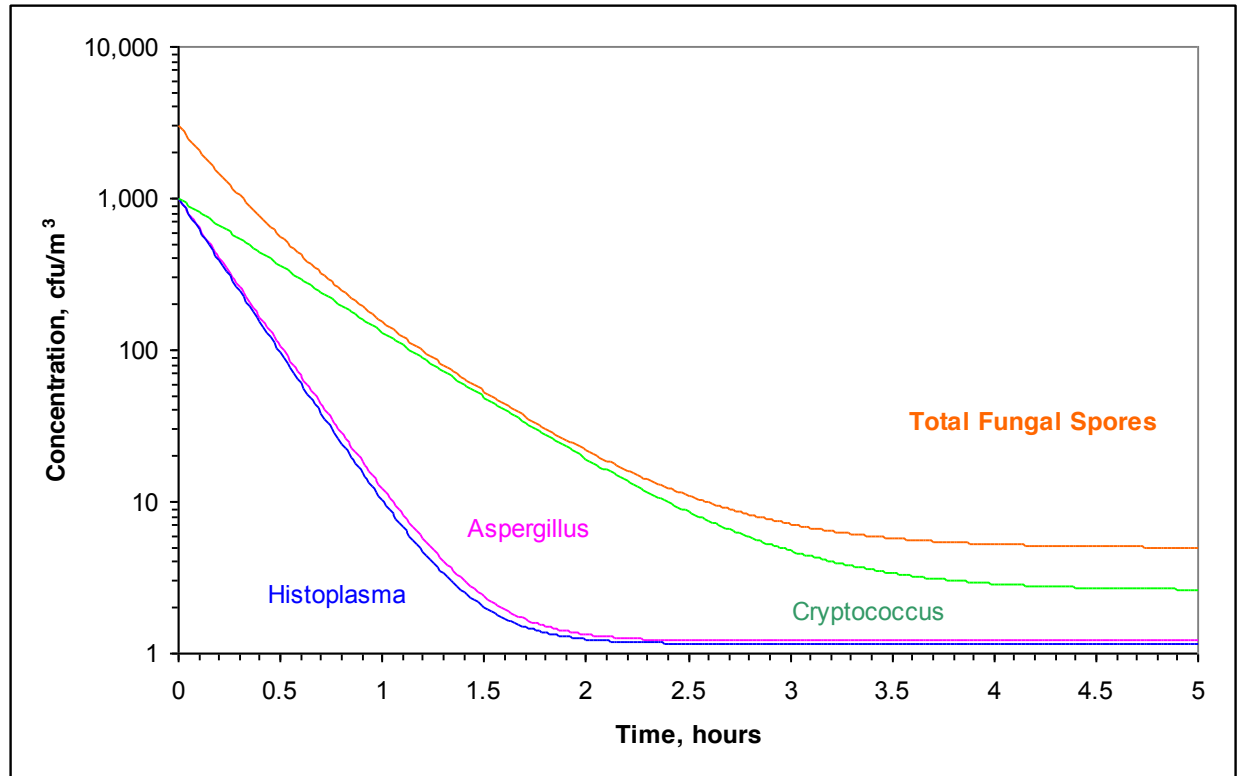


Figure 4: Reduction of airborne concentrations of fungal spores in the DaVita clinic after 5 hours of operation of the UV400 units.

Analysis of Two Stage Decay Model

Fungal spores often exhibit two stages in their decay. The first stage of decay occurs rapidly while the second stage represents a UV-resistant fraction that decays much more slowly under UV exposure. Insufficient data is available to model every fungal spore including the three target fungi, *Aspergillus*, *Cryptococcus*, and *Histoplasma*, but data is available from Kowalski (2009) for the three fungal spores shown in Table 4.

TABLE 4: Two Stage Inactivation Rate Constants

Fungal Spore	Media	k original $\mu\text{W}/\text{cm}^2$	Two Stage Curve				Reference	Surrogate for
			k_1 $\mu\text{W}/\text{cm}^2$	(1-f) Susc.	k_2 $\mu\text{W}/\text{cm}^2$	f Resist.		
<i>Penicillium italicum</i>	W	0.0114	0.017	0.996	0.00500	0.004	Asthana 1992	<i>Aspergillus</i>
<i>Fusarium oxysporum</i>	W	0.0142	0.0155	0.999	0.00370	0.001	Asthana 1992	<i>Histoplasma</i>
<i>Rhizopus nigricans</i>	S	0.0133	0.0285	0.92	0.00203	0.08	Kowalski 2001	<i>Cryptococcus</i>

Penicillium is very similar to *Aspergillus* and could be considered a surrogate fungal spore. *Rhizopus* has a similar UV rate constant to *Cryptococcus* and will be used as a surrogate, while *Fusarium*, which is somewhat similar to *Histoplasma* will be used as a surrogate for it.

The data in Table 4 is applied to a two-stage decay model show as follows:

$$S = (1 - f)e^{-k_1 D} + fe^{-k_2 D} \quad (1)$$

where f = UV resistant fraction (slow decay)

k_1 = first stage rate constant, m^2/J

k_2 = second stage rate constant, m^2/J

Figure 5 shows a generic two stage decay curve where the first stage is separated from the second stage to illustrate the model. The constants from Table 4 are used in conjunction with Equation (1) to model each of the three surrogate spores. The computed survival of these three fungi is performed according to the previous analysis used to predict the performance of the six UV400 units in the model DaVita Clinic. The calculations are not summarized but are similar to the tabulation in Appendix B. Again we find that the final steady state concentrations are well below what would be normal for indoor environments and we can conclude that consideration of the two stage curve has no significant impact on the reductions in airborne concentrations.

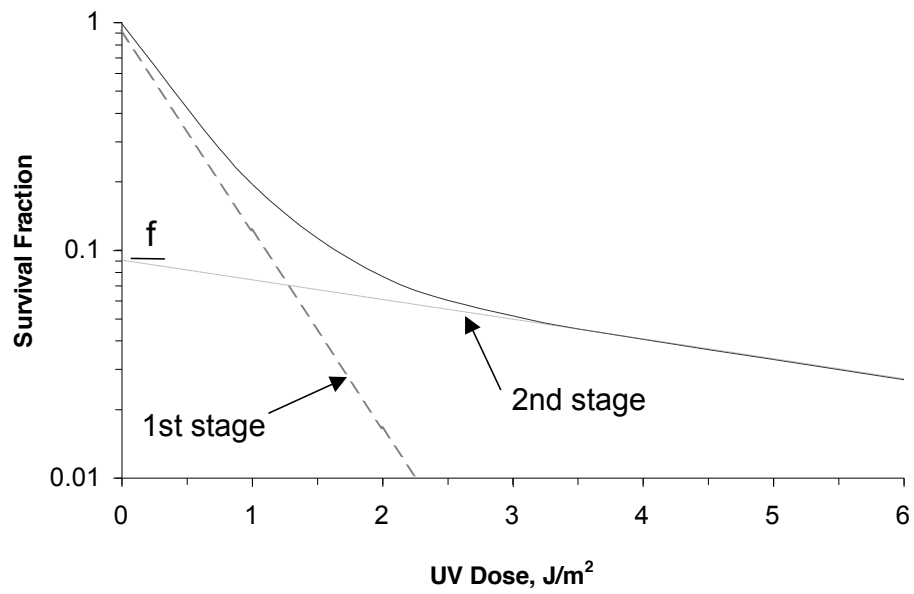


Figure 5: A two stage decay curve is the summation of the first and second stages proportioned by the resistant fraction f .

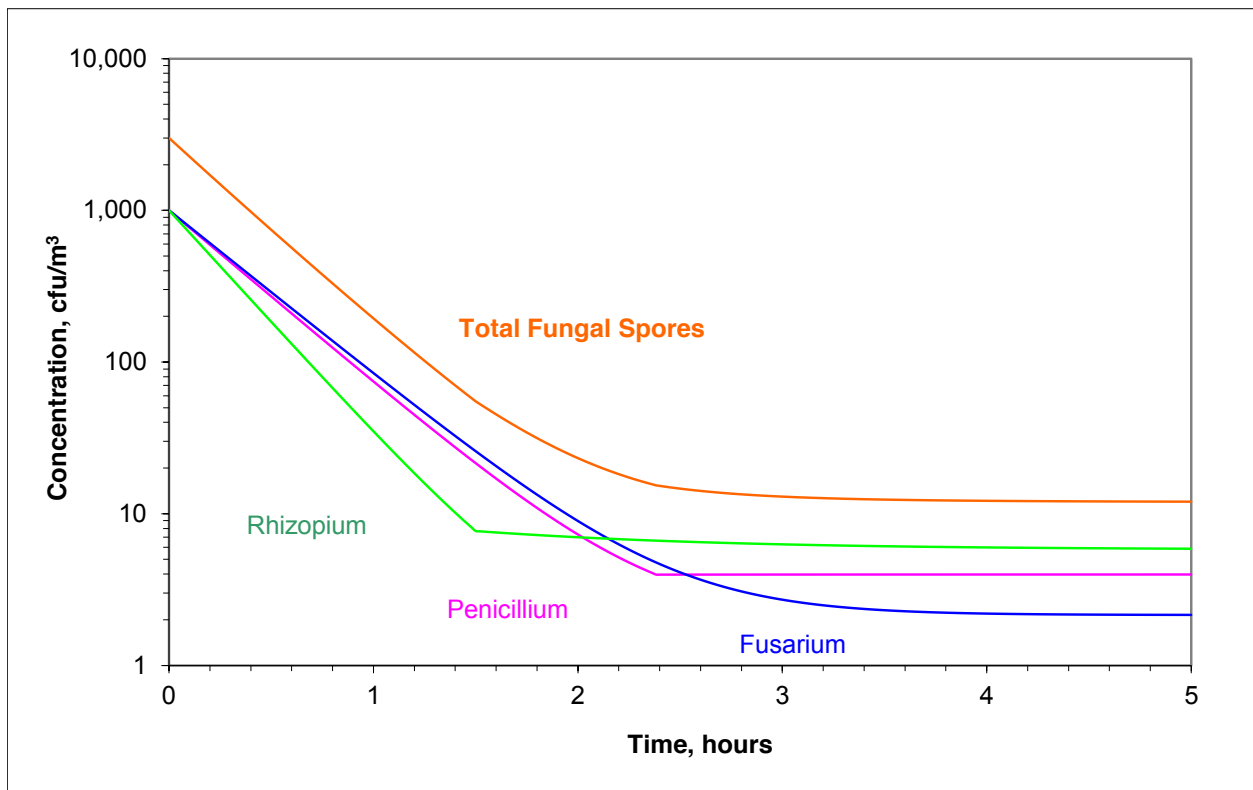


Figure 6: Reduction in airborne concentrations using surrogate fungal spores with two stage decay curves. Compare this with the single stage model in Figure 4.

References

- Asthana, A., and Tuveson, R. W. (1992). "Effects of UV and phototoxins on selected fungal pathogens of citrus." *Int J Plant Sci* 153(3), 442-452.
- ASHRAE (2001). "Standard 62: Ventilation for acceptable indoor air quality." ASHRAE, Atlanta.
- Batterman, S. A., and Burge, H. (1995). "HVAC systems as emission sources affecting indoor air quality: a critical review." *HVAC&R Res* 1(1), 61-80.
- Berglund, B., Berglund, U., and Lindvall, T. (1984). "Characterization of indoor air quality and 'Sick Buildings'." *ASHRAE Trans* 90(1B), 1045-1055.
- Brown, S. K., Sim, M. R., and Abramson, M. (1994). "Concentrations of volatile organic compounds in indoor air -- a review." *Indoor Air* 4, 123-134.
- Brunekreef, B., Douwes, J., Doekes, G., and vanStrien, R. (1999). "Health effects of mould and bacterial components in the home environment." *Indoor Air 99 : Proceedings of the 8th International Conference on Indoor Air Quality and Climate*, Edinburgh, Scotland, 897-898.
- Burge, H. (1990). "Bioaerosols: Prevalence and health effects in the indoor environment." *J Allerg Clin Immunol* 86(5), 687-781.
- Byrd, R. R. (1996). "Prevalence of microbial growth on cooling coils of commercial air-conditioning systems." *The 7th International Conference on IAQ and Climate*, Nagoya, Japan, 203-207.
- Cole, E. C., Foarde, K. K., Leese, K. E., Franke, D. L., and Berry, M. A. (1993). "Biocontaminants in carpeted environments." *Indoor Air 93*, Helsinki, Finland
- Cook, C. E., Cole, E. C., Dulaney, P. D., and Leese, K. E. (1999). "Reservoirs for opportunistic fungi in the home environment: A guide for exposure reduction in the immunocompromised." *Indoor Air 99 : Proceedings of the 8th International Conference on Indoor Air Quality and Climate*, Edinburgh, Scotland, 905-910.
- Dales, R. E., and Miller, D. (1999). "Residential Fungal Contamination and Health: Microbial Cohabitants as Covariates." *Environ Health Perspect* 107(Suppl. 3), 481-483.
- Flannigan, B., McEvoy, E. M., and McGarry, F. (1999). "Investigation of airborne and surface bacteria in homes." *Indoor Air 99 : Proceedings of the 8th International Conference on Indoor Air Quality and Climate*, Edinburgh, Scotland, 884-889.
- Flannigan, B., Samson, R. A., and Miller, J. D. (2001). "*Microorganisms in home and indoor work environments*." Taylor and Francis. Andover, Hants, UK.
- Ginestet, A., Mann, S., Parat, S., Laplanche, S., Salazar, J. H., Pugnet, D., Ehrler, S., and Perdrix, A. (1996). "Bioaerosol filtration efficiency of clean HVAC filters and shedding of micro-organisms from filters loaded with outdoor air." *J Aerosol Sci* 27(Suppl 1), S619-S620.
- Goswami, D. Y., Trivedi, D. M., and Block, S. S. (1997). *Photocatalytic disinfection of indoor air* Transactions of the ASME -- Solar Engineering ASME, ed., 92-96.
- Kemp, S. J., T.H.Kuehn, D.Y.H.Pui, D.Vesley and A.J.Streifel (1995). "Filter collection efficiency and growth of microorganisms on filters loaded with outdoor air." *ASHRAE Transactions* 101(1), 228.
- Kowalski, W. J., W. P. Bahnfleth, T. S. Whittam (1999). "Filtration of Airborne Microorganisms: Modeling and prediction." *ASHRAE Transactions* 105(2), 4-17. <http://www.engr.psu.edu/ae/wjk/fom.html>.

- Kowalski, W. J., Bahnfleth, W. P., Witham, D. L., Severin, B. F., and Whittam, T. S. (2000). "Mathematical modeling of UVGI for air disinfection." *Quantitative Microbiology* 2(3), 249-270.
- Kowalski, W. J., and Bahnfleth, W. P. (2004). "Proposed Standards and Guidelines for UVGI Air Disinfection." *IUVA News* 6(1), 20-25.
- Kowalski, W. J. (2006). *Aerobiological Engineering Handbook: A Guide to Airborne Disease Control Technologies*. McGraw-Hill, New York.
- Kowalski, W. J. (2009). *Ultraviolet Germicidal Irradiation Handbook: UVGI for Air and Surface Disinfection*. Springer, New York.
- Kowalski, W.J. and S. Learned (2011). Ultraviolet Germicidal Irradiation for Air and Surface Disinfection of Animal Facilities, Report for PetAirapy, LLC.
- Kowalski, W.J. (2012). Hospital Airborne Infection Control, CRC Press, Boca Raton.
- Kowalski, W. J. (2013). Residential Application of the Viratech Model UV400 Portable Air Purification Unit, Report for UVFlu Technology, Yarmouthport, MA.
- Kowalski, W.J. (2013). Selection of Microorganisms for Testing. Report for UVFlu Technology, Yarmouthport, MA.
- Kowalski, W.J. (2012). Supplemental Air Purification for Hospitals and Health Care Facilities. Report for UVFlu Technology, Yarmouthport, MA.
- Kowalski, W. J. (2001). *Design and optimization of UVGI air disinfection systems* Doctoral Dissertation, The Pennsylvania State University, State College.
- Kulmala, M., Asmi, A., and Pirjola, L. (1999). "Indoor air aerosol model: The effect of outdoor air, filtration and ventilation on indoor concentrations." *Atmos Environ* 33(14), 2133-2144.
- Lee, S. C., Li, W.-M., and Ao, C.-H. (2002). "Investigation of indoor air quality at residential homes in Hong Kong -- case study." *Atmos Environ* 36, 225-237.
- Li, C., and Y.Kuo (1992). "Airborne characterization of fungi indoors and outdoors." *Journal of Aerosol Science* 23(S1), s667-s670.
- Li, D.-W., and Kendrick, B. (1995). "A year-round comparison of fungal spores in indoor and outdoor air." *Mycologia* 87(2), 190-195.
- Meldrum, J. R., O'Rourke, M. K., Boyer-Pfersdorf, P., and Stetzenbach, L. D. (1993). "Indoor residential mold concentrations as represented by spore and colony counts." *IAQ '93*, Helsinki, 189-194.
- Morey, P. R., Feeley, J. C., and Otten, J. A. (1990). *Biological Contaminants in Indoor Environments*. ASTM, Philadelphia.
- Nevalainen, A., Reponen, T., Heinonen-Tanski, H., and Raunemaa, T. (1991). *Indoor air bacteria in apartment homes before and after occupancy* IAQ '91 , Healthy Buildings/IAQ '91, Washington
- Obee, T. N., and Brown, R. T. (1995). "TiO₂ photocatalysis for indoor air applications: Effects of humidity and trace contaminant levels on the oxidation rates of formaldehyde, toluene, and 1,3 butadiene." *Environ Sci Technol* 29(5), 1223-1231.
- Pasanen, A.-L. (1992). "Airborne mesophilic fungal spores in various residential environments." *Atmos Environ* 26A(16), 2861-2868.
- Reindl, D. T. (1998). "Impacts of Airborne Viruses on Indoor Environments." *3rd Annual Conference on Bioaerosols*,

Saratoga Springs, NY,

- Ren, P., and Leaderer, D. C. (1999). "The nature and concentration of fungi inside and outside homes." *Indoor Air 99 : Proceedings of the 8th International Conference on Indoor Air Quality and Climate*, Edinburgh, Scotland, 930-934.
- Reponen, T. U. of K. L., M.; Raunemaa, T.; Nevalainen, A. (1992). "Effect of indoor sources on fungal spore concentrations and size distributions." *J Aerosol Sci* 23(SUPPL 1), S663-S666.
- Reynolds, S. J., Streifel, A. J., and McJilton, C. E. (1990). "Elevated airborne concentrations of fungi in residential and office environments." *Am Ind Hyg Assoc J* 51, 601-604.
- Rizzo, M., Wadden, R., Scheff, P., and Curtis, L. (1997). "Determination of the contribution of outdoor fungi to indoor bioaerosol concentrations." *Air & Waste Management Association's 90th Annual Meeting & Exhibition*, Toronto, Can
- Shaughnessy, R. J., Levetin, E., and Sublette, K. (1993). "Effectiveness of portable indoor air cleaners in particulate and gaseous contaminant removal." *Indoor Air '93*, Helsinki, Finland
- Shelton, B. G., Kirkland, K. H., Flanders, W. D., and Morris, G. K. (2002). "Profiles of airborne fungi in buildings and outdoor environments in the United States." *Appl Environ Microbiol* 68(4), 1743-1753.
- Speiser, R. (2006). "Portable air purifiers for airborne infection control." *Indoor Environment Connections* 7(12)
- Verhoeff, A. P., VanWijnen, J. H., Brunekreef, B., Fischer, P., VanReenen-Hoekstra, E. S., and Samson, R. A. (1992). "The presence of viable mould propagules in indoor air in relation to home dampness and outdoor air." *Allergy* 47, 83-91.

Appendix A: DaVita Model with Complete Mixing, 15% Outside Air

Time		Indoor Concentrations				Microbes Rem by UV			Microbes Added by OA			Microbes Rem by OA		
min	hr	Virus pfu/m ³	Bacterial cfu/m ³	Fungi cfu/m ³	Total cfu/m ³	Virus pfu	Bacterial cfu	Fungi cfu	Bacteria cfu/m ³	Fungi cfu/m ³	Total cfu/m ³	Virus cfu/m ³	Bacteria cfu/m ³	Fungi cfu/m ³
0	0	10,000	1000	1000	12,000	339790	35654	12879	48	285	333	53519	5352	5352
1	0.02	9,277	925	967	11,168	315210	32968	12454	48	285	333	49647	4949	5175
2	0.03	8,606	855	935	10,396	292407	30485	12043	48	285	333	46056	4576	5005
3	0.05	7,983	791	904	9,678	271254	28189	11646	48	285	333	42724	4231	4840
4	0.07	7,405	731	874	9,011	251631	26066	11262	48	285	333	39633	3913	4680
5	0.08	6,870	676	846	8,391	233428	24103	10891	48	285	333	36766	3618	4526
6	0.10	6,373	625	818	7,816	216541	22288	10533	48	285	333	34107	3346	4377
7	0.12	5,912	578	791	7,281	200876	20610	10187	48	285	333	31639	3094	4233
8	0.13	5,484	535	765	6,784	186345	19059	9852	48	285	333	29350	2861	4094
9	0.15	5,087	494	740	6,322	172864	17624	9528	48	285	333	27227	2646	3959
10	0.17	4,719	457	716	5,892	160359	16298	9215	48	285	333	25258	2446	3829
11	0.18	4,378	423	692	5,493	148758	15072	8913	48	285	333	23430	2262	3704
12	0.20	4,061	391	669	5,122	137997	13939	8621	48	285	333	21735	2092	3582
13	0.22	3,767	362	647	4,776	128014	12890	8339	48	285	333	20163	1935	3465
14	0.23	3,495	334	626	4,456	118753	11921	8066	48	285	333	18704	1789	3352
15	0.25	3,242	309	606	4,157	110163	11025	7802	48	285	333	17351	1655	3242
16	0.27	3,008	286	586	3,880	102193	10197	7547	48	285	333	16096	1531	3136
17	0.28	2,790	265	567	3,621	94801	9431	7301	48	285	333	14932	1416	3034
18	0.30	2,588	245	548	3,381	87943	8723	7063	48	285	333	13852	1309	2935
19	0.32	2,401	226	531	3,158	81581	8068	6833	48	285	333	12849	1211	2839
20	0.33	2,227	209	513	2,950	75679	7463	6610	48	285	333	11920	1120	2747
21	0.35	2,066	194	497	2,756	70204	6903	6396	48	285	333	11058	1036	2658
22	0.37	1,917	179	480	2,576	65126	6385	6188	48	285	333	10258	958	2571
23	0.38	1,778	166	465	2,409	60414	5907	5987	48	285	333	9516	887	2488
24	0.40	1,649	153	450	2,252	56044	5464	5793	48	285	333	8827	820	2407
25	0.42	1,530	142	435	2,107	51990	5055	5606	48	285	333	8189	759	2329
26	0.43	1,419	131	421	1,972	48229	4677	5424	48	285	333	7596	702	2254
27	0.45	1,317	121	408	1,846	44740	4328	5249	48	285	333	7047	650	2181
28	0.47	1,221	112	394	1,728	41503	4004	5080	48	285	333	6537	601	2111
29	0.48	1,133	104	382	1,619	38501	3705	4916	48	285	333	6064	556	2043
30	0.50	1,051	96	369	1,517	35716	3429	4758	48	285	333	5625	515	1977
31	0.52	975	89	358	1,422	33132	3174	4606	48	285	333	5218	476	1914
32	0.53	905	82	346	1,333	30735	2937	4458	48	285	333	4841	441	1852
33	0.55	839	76	335	1,250	28512	2719	4315	48	285	333	4491	408	1793
34	0.57	778	71	324	1,173	26449	2517	4177	48	285	333	4166	378	1736
35	0.58	722	65	314	1,101	24536	2330	4044	48	285	333	3865	350	1680
36	0.60	670	61	304	1,034	22761	2158	3915	48	285	333	3585	324	1627
37	0.62	621	56	294	972	21114	1998	3791	48	285	333	3326	300	1575
38	0.63	576	52	285	913	19587	1850	3670	48	285	333	3085	278	1525
39	0.65	535	48	276	859	18170	1714	3554	48	285	333	2862	257	1477
40	0.67	496	45	267	808	16855	1588	3442	48	285	333	2655	238	1430
41	0.68	460	41	259	760	15636	1471	3333	48	285	333	2463	221	1385
42	0.70	427	38	251	716	14505	1363	3228	48	285	333	2285	205	1341
43	0.72	396	35	243	674	13456	1264	3126	48	285	333	2119	190	1299
44	0.73	367	33	235	635	12482	1171	3028	48	285	333	1966	176	1258
45	0.75	341	30	228	599	11579	1086	2934	48	285	333	1824	163	1219
46	0.77	316	28	221	565	10742	1007	2842	48	285	333	1692	151	1181
47	0.78	293	26	214	533	9965	935	2753	48	285	333	1569	140	1144
48	0.80	272	24	207	504	9244	867	2668	48	285	333	1456	130	1109
49	0.82	252	23	201	476	8575	805	2585	48	285	333	1351	121	1074
50	0.83	234	21	195	450	7955	747	2505	48	285	333	1253	112	1041
51	0.85	217	19	189	425	7379	694	2428	48	285	333	1162	104	1009
52	0.87	201	18	183	402	6845	645	2353	48	285	333	1078	97	978
53	0.88	187	17	177	381	6350	599	2281	48	285	333	1000	90	948
54	0.90	173	16	172	361	5891	557	2211	48	285	333	928	84	919
55	0.92	161	15	166	342	5465	518	2144	48	285	333	861	78	891
56	0.93	149	14	161	324	5069	482	2079	48	285	333	798	72	864
57	0.95	138	13	157	308	4703	449	2016	48	285	333	741	67	838
58	0.97	128	12	152	292	4362	418	1955	48	285	333	687	63	812

59	0.98	119	11	147	277	4047	390	1896	48	285	333	637	59	788
60	1.00	110	10	143	264	3754	364	1839	48	285	333	591	55	764
61	1.02	102	10	139	251	3483	339	1785	48	285	333	549	51	742
62	1.03	95	9	134	238	3231	317	1731	48	285	333	509	48	720
63	1.05	88	8	130	227	2997	296	1680	48	285	333	472	44	698
64	1.07	82	8	127	216	2780	277	1631	48	285	333	438	42	678
65	1.08	76	7	123	206	2579	259	1583	48	285	333	406	39	658
66	1.10	70	7	119	197	2392	243	1536	48	285	333	377	36	638
67	1.12	65	6	116	188	2219	227	1492	48	285	333	350	34	620
68	1.13	61	6	112	179	2059	213	1448	48	285	333	324	32	602
69	1.15	56	6	109	171	1910	200	1407	48	285	333	301	30	585
70	1.17	52	5	106	164	1772	188	1366	48	285	333	279	28	568
71	1.18	48	5	103	156	1644	177	1327	48	285	333	259	27	551
72	1.20	45	5	100	150	1525	167	1289	48	285	333	240	25	536
73	1.22	42	4	97	143	1414	158	1253	48	285	333	223	24	521
74	1.23	39	4	95	137	1312	149	1218	48	285	333	207	22	506
75	1.25	36	4	92	132	1217	141	1184	48	285	333	192	21	492
76	1.27	33	4	89	126	1129	133	1151	48	285	333	178	20	478
77	1.28	31	4	87	121	1047	126	1119	48	285	333	165	19	465
78	1.30	29	3	84	116	972	120	1088	48	285	333	153	18	452
79	1.32	27	3	82	112	901	114	1058	48	285	333	142	17	440
80	1.33	25	3	80	108	836	109	1030	48	285	333	132	16	428
81	1.35	23	3	78	104	776	103	1002	48	285	333	122	16	416
82	1.37	21	3	76	100	720	99	975	48	285	333	113	15	405
83	1.38	20	3	74	96	667	94	949	48	285	333	105	14	394
84	1.40	18	3	72	93	619	90	924	48	285	333	98	14	384
85	1.42	17	2	70	89	574	87	900	48	285	333	90	13	374
86	1.43	16	2	68	86	533	83	876	48	285	333	84	13	364
87	1.45	15	2	66	83	494	80	854	48	285	333	78	12	355
88	1.47	13	2	65	80	459	77	832	48	285	333	72	12	346
89	1.48	13	2	63	78	425	75	811	48	285	333	67	11	337
90	1.50	12	2	61	75	395	72	790	48	285	333	62	11	328
91	1.52	11	2	60	73	366	70	771	48	285	333	58	10	320
92	1.53	10	2	58	70	340	68	752	48	285	333	53	10	312
93	1.55	9	2	57	68	315	66	733	48	285	333	50	10	305
94	1.57	9	2	56	66	292	64	715	48	285	333	46	10	297
95	1.58	8	2	54	64	271	62	698	48	285	333	43	9	290
96	1.60	7	2	53	62	251	61	681	48	285	333	40	9	283
97	1.62	7	2	52	60	233	59	665	48	285	333	37	9	276
98	1.63	6	2	50	58	216	58	650	48	285	333	34	9	270
99	1.65	6	2	49	57	201	56	635	48	285	333	32	8	264
100	1.67	5	2	48	55	186	55	620	48	285	333	29	8	258
101	1.68	5	2	47	54	173	54	606	48	285	333	27	8	252
102	1.70	5	1	46	52	160	53	593	48	285	333	25	8	246
103	1.72	4	1	45	51	149	52	580	48	285	333	23	8	241
104	1.73	4	1	44	50	138	52	567	48	285	333	22	8	236
105	1.75	4	1	43	48	128	51	555	48	285	333	20	8	230
106	1.77	3	1	42	47	119	50	543	48	285	333	19	8	226
107	1.78	3	1	41	46	110	49	531	48	285	333	17	7	221
108	1.80	3	1	40	45	102	49	520	48	285	333	16	7	216
109	1.82	3	1	40	44	95	48	510	48	285	333	15	7	212
110	1.83	3	1	39	43	88	48	499	48	285	333	14	7	207
111	1.85	2	1	38	42	82	47	489	48	285	333	13	7	203
112	1.87	2	1	37	41	76	47	480	48	285	333	12	7	199
113	1.88	2	1	37	40	70	46	470	48	285	333	11	7	195
114	1.90	2	1	36	39	65	46	461	48	285	333	10	7	192
115	1.92	2	1	35	38	60	46	453	48	285	333	10	7	188
116	1.93	2	1	34	37	56	45	444	48	285	333	9	7	185
117	1.95	2	1	34	37	52	45	436	48	285	333	8	7	181
118	1.97	1	1	33	36	48	45	428	48	285	333	8	7	178
119	1.98	1	1	33	35	45	45	421	48	285	333	7	7	175
120	2.00	1	1	32	35	41	44	413	48	285	333	7	7	172
121	2.02	1	1	32	34	38	44	406	48	285	333	6	7	169

122	2.03	1	1	31	33	36	44	399	48	285	333	6	7	166
123	2.05	1	1	30	33	33	44	393	48	285	333	5	7	163
124	2.07	1	1	30	32	31	43	386	48	285	333	5	7	161
125	2.08	1	1	30	32	28	43	380	48	285	333	4	7	158
126	2.10	1	1	29	31	26	43	374	48	285	333	4	6	155
127	2.12	1	1	29	31	25	43	368	48	285	333	4	6	153
128	2.13	1	1	28	30	23	43	363	48	285	333	4	6	151
129	2.15	1	1	28	30	21	43	357	48	285	333	3	6	148
130	2.17	1	1	27	29	20	43	352	48	285	333	3	6	146
131	2.18	1	1	27	29	18	43	347	48	285	333	3	6	144
132	2.20	0	1	27	28	17	43	342	48	285	333	3	6	142
133	2.22	0	1	26	28	16	42	337	48	285	333	2	6	140
134	2.23	0	1	26	27	14	42	333	48	285	333	2	6	138
135	2.25	0	1	26	27	13	42	329	48	285	333	2	6	137
136	2.27	0	1	25	27	12	42	324	48	285	333	2	6	135
137	2.28	0	1	25	26	12	42	320	48	285	333	2	6	133
138	2.30	0	1	25	26	11	42	316	48	285	333	2	6	131
139	2.32	0	1	24	26	10	42	312	48	285	333	2	6	130
140	2.33	0	1	24	25	9	42	309	48	285	333	1	6	128
141	2.35	0	1	24	25	9	42	305	48	285	333	1	6	127
142	2.37	0	1	23	25	8	42	302	48	285	333	1	6	125
143	2.38	0	1	23	25	7	42	298	48	285	333	1	6	124
144	2.40	0	1	23	24	7	42	295	48	285	333	1	6	123
145	2.42	0	1	23	24	6	42	292	48	285	333	1	6	121
146	2.43	0	1	22	24	6	42	289	48	285	333	1	6	120
147	2.45	0	1	22	24	5	42	286	48	285	333	1	6	119
148	2.47	0	1	22	23	5	42	283	48	285	333	1	6	118
149	2.48	0	1	22	23	5	42	280	48	285	333	1	6	116
150	2.50	0	1	22	23	4	42	278	48	285	333	1	6	115
151	2.52	0	1	21	23	4	42	275	48	285	333	1	6	114
152	2.53	0	1	21	22	4	42	273	48	285	333	1	6	113
153	2.55	0	1	21	22	3	42	270	48	285	333	1	6	112
154	2.57	0	1	21	22	3	42	268	48	285	333	1	6	111
155	2.58	0	1	21	22	3	42	266	48	285	333	0	6	110
156	2.60	0	1	20	22	3	42	264	48	285	333	0	6	110
157	2.62	0	1	20	22	3	42	262	48	285	333	0	6	109
158	2.63	0	1	20	21	2	42	260	48	285	333	0	6	108
159	2.65	0	1	20	21	2	42	258	48	285	333	0	6	107
160	2.67	0	1	20	21	2	41	256	48	285	333	0	6	106
161	2.68	0	1	20	21	2	41	254	48	285	333	0	6	106
162	2.70	0	1	20	21	2	41	252	48	285	333	0	6	105
163	2.72	0	1	19	21	2	41	250	48	285	333	0	6	104
164	2.73	0	1	19	21	2	41	249	48	285	333	0	6	103
165	2.75	0	1	19	20	1	41	247	48	285	333	0	6	103
166	2.77	0	1	19	20	1	41	246	48	285	333	0	6	102
167	2.78	0	1	19	20	1	41	244	48	285	333	0	6	101
168	2.80	0	1	19	20	1	41	243	48	285	333	0	6	101
169	2.82	0	1	19	20	1	41	241	48	285	333	0	6	100
170	2.83	0	1	19	20	1	41	240	48	285	333	0	6	100
171	2.85	0	1	19	20	1	41	239	48	285	333	0	6	99
172	2.87	0	1	18	20	1	41	238	48	285	333	0	6	99
173	2.88	0	1	18	20	1	41	236	48	285	333	0	6	98
174	2.90	0	1	18	19	1	41	235	48	285	333	0	6	98
175	2.92	0	1	18	19	1	41	234	48	285	333	0	6	97
176	2.93	0	1	18	19	1	41	233	48	285	333	0	6	97
177	2.95	0	1	18	19	1	41	232	48	285	333	0	6	96
178	2.97	0	1	18	19	1	41	231	48	285	333	0	6	96
179	2.98	0	1	18	19	0	41	230	48	285	333	0	6	96
180	3.00	0	1	18	19	0	41	229	48	285	333	0	6	95
181	3.02	0	1	18	19	0	41	228	48	285	333	0	6	95
182	3.03	0	1	18	19	0	41	227	48	285	333	0	6	94
183	3.05	0	1	18	19	0	41	226	48	285	333	0	6	94
184	3.07	0	1	18	19	0	41	225	48	285	333	0	6	94

185	3.08	0	1	17	19	0	41	225	48	285	333	0	6	93
186	3.10	0	1	17	19	0	41	224	48	285	333	0	6	93
187	3.12	0	1	17	18	0	41	223	48	285	333	0	6	93
188	3.13	0	1	17	18	0	41	222	48	285	333	0	6	92
189	3.15	0	1	17	18	0	41	222	48	285	333	0	6	92
190	3.17	0	1	17	18	0	41	221	48	285	333	0	6	92
191	3.18	0	1	17	18	0	41	220	48	285	333	0	6	92
192	3.20	0	1	17	18	0	41	220	48	285	333	0	6	91
193	3.22	0	1	17	18	0	41	219	48	285	333	0	6	91
194	3.23	0	1	17	18	0	41	219	48	285	333	0	6	91
195	3.25	0	1	17	18	0	41	218	48	285	333	0	6	91
196	3.27	0	1	17	18	0	41	217	48	285	333	0	6	90
197	3.28	0	1	17	18	0	41	217	48	285	333	0	6	90
198	3.30	0	1	17	18	0	41	216	48	285	333	0	6	90
199	3.32	0	1	17	18	0	41	216	48	285	333	0	6	90
200	3.33	0	1	17	18	0	41	215	48	285	333	0	6	90
201	3.35	0	1	17	18	0	41	215	48	285	333	0	6	89
202	3.37	0	1	17	18	0	41	215	48	285	333	0	6	89
203	3.38	0	1	17	18	0	41	214	48	285	333	0	6	89
204	3.40	0	1	17	18	0	41	214	48	285	333	0	6	89
205	3.42	0	1	17	18	0	41	213	48	285	333	0	6	89
206	3.43	0	1	17	18	0	41	213	48	285	333	0	6	88
207	3.45	0	1	17	18	0	41	213	48	285	333	0	6	88
208	3.47	0	1	16	18	0	41	212	48	285	333	0	6	88
209	3.48	0	1	16	18	0	41	212	48	285	333	0	6	88
210	3.50	0	1	16	18	0	41	211	48	285	333	0	6	88
211	3.52	0	1	16	18	0	41	211	48	285	333	0	6	88
212	3.53	0	1	16	18	0	41	211	48	285	333	0	6	88
213	3.55	0	1	16	18	0	41	211	48	285	333	0	6	87
214	3.57	0	1	16	17	0	41	210	48	285	333	0	6	87
215	3.58	0	1	16	17	0	41	210	48	285	333	0	6	87
216	3.60	0	1	16	17	0	41	210	48	285	333	0	6	87
217	3.62	0	1	16	17	0	41	209	48	285	333	0	6	87
218	3.63	0	1	16	17	0	41	209	48	285	333	0	6	87
219	3.65	0	1	16	17	0	41	209	48	285	333	0	6	87
220	3.67	0	1	16	17	0	41	209	48	285	333	0	6	87
221	3.68	0	1	16	17	0	41	208	48	285	333	0	6	87
222	3.70	0	1	16	17	0	41	208	48	285	333	0	6	87
223	3.72	0	1	16	17	0	41	208	48	285	333	0	6	86
224	3.73	0	1	16	17	0	41	208	48	285	333	0	6	86
225	3.75	0	1	16	17	0	41	208	48	285	333	0	6	86
226	3.77	0	1	16	17	0	41	207	48	285	333	0	6	86
227	3.78	0	1	16	17	0	41	207	48	285	333	0	6	86
228	3.80	0	1	16	17	0	41	207	48	285	333	0	6	86
229	3.82	0	1	16	17	0	41	207	48	285	333	0	6	86
230	3.83	0	1	16	17	0	41	207	48	285	333	0	6	86
231	3.85	0	1	16	17	0	41	206	48	285	333	0	6	86
232	3.87	0	1	16	17	0	41	206	48	285	333	0	6	86
233	3.88	0	1	16	17	0	41	206	48	285	333	0	6	86
234	3.90	0	1	16	17	0	41	206	48	285	333	0	6	86
235	3.92	0	1	16	17	0	41	206	48	285	333	0	6	86
236	3.93	0	1	16	17	0	41	206	48	285	333	0	6	85
237	3.95	0	1	16	17	0	41	206	48	285	333	0	6	85
238	3.97	0	1	16	17	0	41	205	48	285	333	0	6	85

239	3.98	0	1	16	17	0	41	205	48	285	333	0	6	85
240	4.00	0	1	16	17	0	41	205	48	285	333	0	6	85
241	4.02	0	1	16	17	0	41	205	48	285	333	0	6	85
242	4.03	0	1	16	17	0	41	205	48	285	333	0	6	85
243	4.05	0	1	16	17	0	41	205	48	285	333	0	6	85
244	4.07	0	1	16	17	0	41	205	48	285	333	0	6	85
245	4.08	0	1	16	17	0	41	205	48	285	333	0	6	85
246	4.10	0	1	16	17	0	41	205	48	285	333	0	6	85
247	4.12	0	1	16	17	0	41	204	48	285	333	0	6	85
248	4.13	0	1	16	17	0	41	204	48	285	333	0	6	85
249	4.15	0	1	16	17	0	41	204	48	285	333	0	6	85
250	4.17	0	1	16	17	0	41	204	48	285	333	0	6	85
251	4.18	0	1	16	17	0	41	204	48	285	333	0	6	85
252	4.20	0	1	16	17	0	41	204	48	285	333	0	6	85
253	4.22	0	1	16	17	0	41	204	48	285	333	0	6	85
254	4.23	0	1	16	17	0	41	204	48	285	333	0	6	85
255	4.25	0	1	16	17	0	41	204	48	285	333	0	6	85
256	4.27	0	1	16	17	0	41	204	48	285	333	0	6	85
257	4.28	0	1	16	17	0	41	204	48	285	333	0	6	85
258	4.30	0	1	16	17	0	41	204	48	285	333	0	6	85
259	4.32	0	1	16	17	0	41	203	48	285	333	0	6	85
260	4.33	0	1	16	17	0	41	203	48	285	333	0	6	85
261	4.35	0	1	16	17	0	41	203	48	285	333	0	6	85
262	4.37	0	1	16	17	0	41	203	48	285	333	0	6	84
263	4.38	0	1	16	17	0	41	203	48	285	333	0	6	84
264	4.40	0	1	16	17	0	41	203	48	285	333	0	6	84
265	4.42	0	1	16	17	0	41	203	48	285	333	0	6	84
266	4.43	0	1	16	17	0	41	203	48	285	333	0	6	84
267	4.45	0	1	16	17	0	41	203	48	285	333	0	6	84
268	4.47	0	1	16	17	0	41	203	48	285	333	0	6	84
269	4.48	0	1	16	17	0	41	203	48	285	333	0	6	84
270	4.50	0	1	16	17	0	41	203	48	285	333	0	6	84
271	4.52	0	1	16	17	0	41	203	48	285	333	0	6	84
272	4.53	0	1	16	17	0	41	203	48	285	333	0	6	84
273	4.55	0	1	16	17	0	41	203	48	285	333	0	6	84
274	4.57	0	1	16	17	0	41	203	48	285	333	0	6	84
275	4.58	0	1	16	17	0	41	203	48	285	333	0	6	84
276	4.60	0	1	16	17	0	41	203	48	285	333	0	6	84
277	4.62	0	1	16	17	0	41	203	48	285	333	0	6	84
278	4.63	0	1	16	17	0	41	203	48	285	333	0	6	84
279	4.65	0	1	16	17	0	41	203	48	285	333	0	6	84
280	4.67	0	1	16	17	0	41	203	48	285	333	0	6	84
281	4.68	0	1	16	17	0	41	203	48	285	333	0	6	84
282	4.70	0	1	16	17	0	41	202	48	285	333	0	6	84
283	4.72	0	1	16	17	0	41	202	48	285	333	0	6	84
284	4.73	0	1	16	17	0	41	202	48	285	333	0	6	84
285	4.75	0	1	16	17	0	41	202	48	285	333	0	6	84
286	4.77	0	1	16	17	0	41	202	48	285	333	0	6	84
287	4.78	0	1	16	17	0	41	202	48	285	333	0	6	84
288	4.80	0	1	16	17	0	41	202	48	285	333	0	6	84
289	4.82	0	1	16	17	0	41	202	48	285	333	0	6	84
290	4.83	0	1	16	17	0	41	202	48	285	333	0	6	84
291	4.85	0	1	16	17	0	41	202	48	285	333	0	6	84
292	4.87	0	1	16	17	0	41	202	48	285	333	0	6	84
293	4.88	0	1	16	17	0	41	202	48	285	333	0	6	84
294	4.90	0	1	16	17	0	41	202	48	285	333	0	6	84
295	4.92	0	1	16	17	0	41	202	48	285	333	0	6	84
296	4.93	0	1	16	17	0	41	202	48	285	333	0	6	84
297	4.95	0	1	16	17	0	41	202	48	285	333	0	6	84
298	4.97	0	1	16	17	0	41	202	48	285	333	0	6	84
299	4.98	0	1	16	17	0	41	202	48	285	333	0	6	84
300	5.00	0	1	16	17	0	41	202	48	285	333	0	6	84

Appendix B: DaVita Model for Fungi with Complete Mixing, 15% Outside Air

Time		Indoor Concentrations				Microbes Rem by UV			Microbes Added by OA			Microbes Rem by OA		
min	hr	Asper pfu/m ³	Histo cfu/m ³	Crypto cfu/m ³	Total cfu/m ³	Asper pfu	Histo cfu	Crypto cfu	Asper cfu/m ³	Histo cfu/m ³	Crypto cfu/m ³	Asper cfu/m ³	Histo cfu/m ³	Crypto cfu/m ³
0	0	1,000	1000	1000	3,000	33979	35654	12879	48	48	48	5352	5352	5352
1	0.02	928	925	967	2,819	31524	32968	12448	48	48	48	4965	4949	5173
2	0.03	861	855	934	2,650	29246	30485	12032	48	48	48	4606	4576	5000
3	0.05	799	791	903	2,492	27134	28189	11630	48	48	48	4274	4231	4833
4	0.07	741	731	873	2,345	25174	26066	11241	48	48	48	3965	3913	4671
5	0.08	687	676	844	2,207	23356	24103	10865	48	48	48	3679	3618	4515
6	0.10	638	625	815	2,078	21669	22288	10502	48	48	48	3413	3346	4364
7	0.12	592	578	788	1,958	20104	20610	10151	48	48	48	3167	3094	4218
8	0.13	549	535	762	1,845	18653	19059	9812	48	48	48	2938	2861	4077
9	0.15	509	494	736	1,740	17307	17624	9484	48	48	48	2726	2646	3941
10	0.17	473	457	712	1,641	16058	16298	9167	48	48	48	2529	2446	3809
11	0.18	438	423	688	1,549	14899	15072	8861	48	48	48	2347	2262	3682
12	0.20	407	391	665	1,463	13824	13939	8565	48	48	48	2177	2092	3559
13	0.22	377	362	643	1,382	12827	12890	8279	48	48	48	2020	1935	3440
14	0.23	350	334	621	1,306	11902	11921	8002	48	48	48	1875	1789	3325
15	0.25	325	309	601	1,235	11044	11025	7735	48	48	48	1740	1655	3214
16	0.27	302	286	581	1,168	10248	10197	7477	48	48	48	1614	1531	3107
17	0.28	280	265	561	1,106	9510	9431	7227	48	48	48	1498	1416	3003
18	0.30	260	245	542	1,047	8825	8723	6986	48	48	48	1390	1309	2903
19	0.32	241	226	524	992	8189	8068	6753	48	48	48	1290	1211	2806
20	0.33	224	209	507	940	7600	7463	6527	48	48	48	1197	1120	2712
21	0.35	208	194	490	891	7053	6903	6310	48	48	48	1111	1036	2622
22	0.37	193	179	474	845	6546	6385	6099	48	48	48	1031	958	2535
23	0.38	179	166	458	802	6075	5907	5896	48	48	48	957	887	2450
24	0.40	166	153	443	762	5639	5464	5699	48	48	48	888	820	2368
25	0.42	154	142	428	724	5234	5055	5509	48	48	48	824	759	2289
26	0.43	143	131	414	688	4858	4677	5326	48	48	48	765	702	2213
27	0.45	133	121	400	654	4510	4328	5148	48	48	48	710	650	2139
28	0.47	123	112	386	622	4186	4004	4977	48	48	48	659	601	2068
29	0.48	114	104	374	592	3887	3705	4811	48	48	48	612	556	1999
30	0.50	106	96	361	563	3608	3429	4651	48	48	48	568	515	1933
31	0.52	99	89	349	537	3350	3174	4496	48	48	48	528	476	1868
32	0.53	92	82	337	511	3111	2937	4346	48	48	48	490	441	1806
33	0.55	85	76	326	488	2889	2719	4202	48	48	48	455	408	1746
34	0.57	79	71	315	465	2683	2517	4062	48	48	48	423	378	1688
35	0.58	73	65	305	444	2492	2330	3927	48	48	48	392	350	1632
36	0.60	68	61	295	423	2314	2158	3796	48	48	48	365	324	1578
37	0.62	63	56	285	404	2150	1998	3670	48	48	48	339	300	1525
38	0.63	59	52	275	386	1997	1850	3548	48	48	48	315	278	1474
39	0.65	55	48	266	369	1856	1714	3430	48	48	48	292	257	1425
40	0.67	51	45	258	353	1725	1588	3316	48	48	48	272	238	1378
41	0.68	47	41	249	337	1603	1471	3206	48	48	48	252	221	1332
42	0.70	44	38	241	323	1490	1363	3100	48	48	48	235	205	1288
43	0.72	41	35	233	309	1385	1264	2997	48	48	48	218	190	1245
44	0.73	38	33	225	296	1288	1171	2898	48	48	48	203	176	1204
45	0.75	35	30	218	283	1198	1086	2802	48	48	48	189	163	1164
46	0.77	33	28	210	271	1114	1007	2709	48	48	48	175	151	1126
47	0.78	30	26	203	260	1036	935	2619	48	48	48	163	140	1088
48	0.80	28	24	197	249	964	867	2532	48	48	48	152	130	1052
49	0.82	26	23	190	239	898	805	2449	48	48	48	141	121	1018
50	0.83	25	21	184	229	836	747	2368	48	48	48	132	112	984
51	0.85	23	19	178	220	778	694	2289	48	48	48	123	104	951
52	0.87	21	18	172	211	725	645	2214	48	48	48	114	97	920
53	0.88	20	17	166	203	675	599	2141	48	48	48	106	90	890
54	0.90	19	16	161	195	629	557	2070	48	48	48	99	84	860
55	0.92	17	15	155	187	587	518	2002	48	48	48	92	78	832
56	0.93	16	14	150	180	547	482	1936	48	48	48	86	72	804
57	0.95	15	13	145	173	511	449	1872	48	48	48	80	67	778
58	0.97	14	12	141	166	477	418	1810	48	48	48	75	63	752

59	0.98	13	11	136	160	445	390	1751	48	48	48	70	59	728
60	1.00	12	10	131	154	416	364	1693	48	48	48	66	55	704
61	1.02	11	10	127	148	389	339	1638	48	48	48	61	51	680
62	1.03	11	9	123	143	364	317	1584	48	48	48	57	48	658
63	1.05	10	8	119	137	340	296	1532	48	48	48	54	44	637
64	1.07	9	8	115	132	319	277	1482	48	48	48	50	42	616
65	1.08	9	7	111	127	299	259	1433	48	48	48	47	39	595
66	1.10	8	7	108	123	280	243	1386	48	48	48	44	36	576
67	1.12	8	6	104	118	263	227	1341	48	48	48	41	34	557
68	1.13	7	6	101	114	247	213	1297	48	48	48	39	32	539
69	1.15	7	6	97	110	232	200	1255	48	48	48	37	30	521
70	1.17	6	5	94	106	218	188	1214	48	48	48	34	28	504
71	1.18	6	5	91	102	205	177	1174	48	48	48	32	27	488
72	1.20	6	5	88	99	193	167	1136	48	48	48	30	25	472
73	1.22	5	4	85	95	182	158	1099	48	48	48	29	24	457
74	1.23	5	4	83	92	172	149	1063	48	48	48	27	22	442
75	1.25	5	4	80	89	163	141	1029	48	48	48	26	21	427
76	1.27	5	4	77	86	154	133	995	48	48	48	24	20	414
77	1.28	4	4	75	83	146	126	963	48	48	48	23	19	400
78	1.30	4	3	72	80	138	120	932	48	48	48	22	18	387
79	1.32	4	3	70	77	131	114	902	48	48	48	21	17	375
80	1.33	4	3	68	74	125	109	873	48	48	48	20	16	363
81	1.35	3	3	66	72	119	103	844	48	48	48	19	16	351
82	1.37	3	3	63	70	113	99	817	48	48	48	18	15	340
83	1.38	3	3	61	67	108	94	791	48	48	48	17	14	329
84	1.40	3	3	59	65	103	90	766	48	48	48	16	14	318
85	1.42	3	2	58	63	98	87	741	48	48	48	16	13	308
86	1.43	3	2	56	61	94	83	717	48	48	48	15	13	298
87	1.45	3	2	54	59	90	80	694	48	48	48	14	12	289
88	1.47	3	2	52	57	87	77	672	48	48	48	14	12	279
89	1.48	2	2	51	55	84	75	651	48	48	48	13	11	270
90	1.50	2	2	49	53	81	72	630	48	48	48	13	11	262
91	1.52	2	2	47	52	78	70	610	48	48	48	12	10	254
92	1.53	2	2	46	50	75	68	591	48	48	48	12	10	245
93	1.55	2	2	44	48	73	66	572	48	48	48	11	10	238
94	1.57	2	2	43	47	70	64	554	48	48	48	11	10	230
95	1.58	2	2	42	45	68	62	537	48	48	48	11	9	223
96	1.60	2	2	40	44	66	61	520	48	48	48	10	9	216
97	1.62	2	2	39	43	64	59	503	48	48	48	10	9	209
98	1.63	2	2	38	41	63	58	488	48	48	48	10	9	203
99	1.65	2	2	37	40	61	56	472	48	48	48	10	8	196
100	1.67	2	2	36	39	60	55	458	48	48	48	9	8	190
101	1.68	2	2	34	38	58	54	444	48	48	48	9	8	184
102	1.70	2	1	33	37	57	53	430	48	48	48	9	8	179
103	1.72	2	1	32	35	56	52	416	48	48	48	9	8	173
104	1.73	2	1	31	34	55	52	404	48	48	48	9	8	168
105	1.75	2	1	30	33	54	51	391	48	48	48	8	8	163
106	1.77	2	1	29	32	53	50	379	48	48	48	8	8	158
107	1.78	2	1	29	31	52	49	368	48	48	48	8	7	153
108	1.80	2	1	28	31	51	49	356	48	48	48	8	7	148
109	1.82	1	1	27	30	51	48	346	48	48	48	8	7	144
110	1.83	1	1	26	29	50	48	335	48	48	48	8	7	139
111	1.85	1	1	25	28	49	47	325	48	48	48	8	7	135
112	1.87	1	1	24	27	49	47	315	48	48	48	8	7	131
113	1.88	1	1	24	26	48	46	306	48	48	48	8	7	127
114	1.90	1	1	23	26	48	46	297	48	48	48	7	7	123
115	1.92	1	1	22	25	47	46	288	48	48	48	7	7	120
116	1.93	1	1	22	24	47	45	279	48	48	48	7	7	116
117	1.95	1	1	21	24	46	45	271	48	48	48	7	7	113
118	1.97	1	1	20	23	46	45	263	48	48	48	7	7	109
119	1.98	1	1	20	22	46	45	255	48	48	48	7	7	106
120	2.00	1	1	19	22	45	44	248	48	48	48	7	7	103
121	2.02	1	1	19	21	45	44	241	48	48	48	7	7	100

122	2.03	1	1	18	21	45	44	234	48	48	48	7	7	97
123	2.05	1	1	18	20	44	44	227	48	48	48	7	7	94
124	2.07	1	1	17	20	44	43	221	48	48	48	7	7	92
125	2.08	1	1	17	19	44	43	214	48	48	48	7	7	89
126	2.10	1	1	16	19	44	43	208	48	48	48	7	6	87
127	2.12	1	1	16	18	44	43	202	48	48	48	7	6	84
128	2.13	1	1	15	18	43	43	197	48	48	48	7	6	82
129	2.15	1	1	15	17	43	43	191	48	48	48	7	6	80
130	2.17	1	1	14	17	43	43	186	48	48	48	7	6	77
131	2.18	1	1	14	17	43	43	181	48	48	48	7	6	75
132	2.20	1	1	14	16	43	43	176	48	48	48	7	6	73
133	2.22	1	1	13	16	43	42	171	48	48	48	7	6	71
134	2.23	1	1	13	15	43	42	167	48	48	48	7	6	69
135	2.25	1	1	13	15	42	42	162	48	48	48	7	6	67
136	2.27	1	1	12	15	42	42	158	48	48	48	7	6	66
137	2.28	1	1	12	14	42	42	154	48	48	48	7	6	64
138	2.30	1	1	12	14	42	42	150	48	48	48	7	6	62
139	2.32	1	1	11	14	42	42	146	48	48	48	7	6	61
140	2.33	1	1	11	13	42	42	142	48	48	48	7	6	59
141	2.35	1	1	11	13	42	42	138	48	48	48	7	6	57
142	2.37	1	1	10	13	42	42	135	48	48	48	7	6	56
143	2.38	1	1	10	13	42	42	131	48	48	48	7	6	55
144	2.40	1	1	10	12	42	42	128	48	48	48	7	6	53
145	2.42	1	1	10	12	42	42	125	48	48	48	7	6	52
146	2.43	1	1	9	12	42	42	122	48	48	48	7	6	51
147	2.45	1	1	9	12	42	42	119	48	48	48	7	6	49
148	2.47	1	1	9	11	42	42	116	48	48	48	7	6	48
149	2.48	1	1	9	11	42	42	113	48	48	48	7	6	47
150	2.50	1	1	9	11	42	42	111	48	48	48	7	6	46
151	2.52	1	1	8	11	42	42	108	48	48	48	7	6	45
152	2.53	1	1	8	11	41	42	106	48	48	48	7	6	44
153	2.55	1	1	8	10	41	42	103	48	48	48	7	6	43
154	2.57	1	1	8	10	41	42	101	48	48	48	7	6	42
155	2.58	1	1	8	10	41	42	99	48	48	48	7	6	41
156	2.60	1	1	7	10	41	42	96	48	48	48	7	6	40
157	2.62	1	1	7	10	41	42	94	48	48	48	7	6	39
158	2.63	1	1	7	10	41	42	92	48	48	48	7	6	38
159	2.65	1	1	7	9	41	42	90	48	48	48	7	6	38
160	2.67	1	1	7	9	41	41	88	48	48	48	7	6	37
161	2.68	1	1	7	9	41	41	87	48	48	48	7	6	36
162	2.70	1	1	7	9	41	41	85	48	48	48	7	6	35
163	2.72	1	1	6	9	41	41	83	48	48	48	6	6	35
164	2.73	1	1	6	9	41	41	81	48	48	48	6	6	34
165	2.75	1	1	6	9	41	41	80	48	48	48	6	6	33
166	2.77	1	1	6	8	41	41	78	48	48	48	6	6	33
167	2.78	1	1	6	8	41	41	77	48	48	48	6	6	32
168	2.80	1	1	6	8	41	41	75	48	48	48	6	6	31
169	2.82	1	1	6	8	41	41	74	48	48	48	6	6	31
170	2.83	1	1	6	8	41	41	73	48	48	48	6	6	30
171	2.85	1	1	6	8	41	41	71	48	48	48	6	6	30
172	2.87	1	1	5	8	41	41	70	48	48	48	6	6	29
173	2.88	1	1	5	8	41	41	69	48	48	48	6	6	29
174	2.90	1	1	5	8	41	41	68	48	48	48	6	6	28
175	2.92	1	1	5	8	41	41	66	48	48	48	6	6	28
176	2.93	1	1	5	7	41	41	65	48	48	48	6	6	27
177	2.95	1	1	5	7	41	41	64	48	48	48	6	6	27
178	2.97	1	1	5	7	41	41	63	48	48	48	6	6	26
179	2.98	1	1	5	7	41	41	62	48	48	48	6	6	26
180	3.00	1	1	5	7	41	41	61	48	48	48	6	6	25
181	3.02	1	1	5	7	41	41	60	48	48	48	6	6	25
182	3.03	1	1	5	7	41	41	59	48	48	48	6	6	25
183	3.05	1	1	5	7	41	41	59	48	48	48	6	6	24
184	3.07	1	1	4	7	41	41	58	48	48	48	6	6	24

185	3.08	1	1	4	7	41	41	57	48	48	48	6	6	24
186	3.10	1	1	4	7	41	41	56	48	48	48	6	6	23
187	3.12	1	1	4	7	41	41	55	48	48	48	6	6	23
188	3.13	1	1	4	7	41	41	55	48	48	48	6	6	23
189	3.15	1	1	4	7	41	41	54	48	48	48	6	6	22
190	3.17	1	1	4	7	41	41	53	48	48	48	6	6	22
191	3.18	1	1	4	6	41	41	53	48	48	48	6	6	22
192	3.20	1	1	4	6	41	41	52	48	48	48	6	6	22
193	3.22	1	1	4	6	41	41	51	48	48	48	6	6	21
194	3.23	1	1	4	6	41	41	51	48	48	48	6	6	21
195	3.25	1	1	4	6	41	41	50	48	48	48	6	6	21
196	3.27	1	1	4	6	41	41	50	48	48	48	6	6	21
197	3.28	1	1	4	6	41	41	49	48	48	48	6	6	20
198	3.30	1	1	4	6	41	41	49	48	48	48	6	6	20
199	3.32	1	1	4	6	41	41	48	48	48	48	6	6	20
200	3.33	1	1	4	6	41	41	48	48	48	48	6	6	20
201	3.35	1	1	4	6	41	41	47	48	48	48	6	6	20
202	3.37	1	1	4	6	41	41	47	48	48	48	6	6	19
203	3.38	1	1	4	6	41	41	46	48	48	48	6	6	19
204	3.40	1	1	4	6	41	41	46	48	48	48	6	6	19
205	3.42	1	1	4	6	41	41	45	48	48	48	6	6	19
206	3.43	1	1	3	6	41	41	45	48	48	48	6	6	19
207	3.45	1	1	3	6	41	41	45	48	48	48	6	6	19
208	3.47	1	1	3	6	41	41	44	48	48	48	6	6	18
209	3.48	1	1	3	6	41	41	44	48	48	48	6	6	18
210	3.50	1	1	3	6	41	41	44	48	48	48	6	6	18
211	3.52	1	1	3	6	41	41	43	48	48	48	6	6	18
212	3.53	1	1	3	6	41	41	43	48	48	48	6	6	18
213	3.55	1	1	3	6	41	41	43	48	48	48	6	6	18
214	3.57	1	1	3	6	41	41	42	48	48	48	6	6	18
215	3.58	1	1	3	6	41	41	42	48	48	48	6	6	17
216	3.60	1	1	3	6	41	41	42	48	48	48	6	6	17
217	3.62	1	1	3	6	41	41	41	48	48	48	6	6	17
218	3.63	1	1	3	6	41	41	41	48	48	48	6	6	17
219	3.65	1	1	3	6	41	41	41	48	48	48	6	6	17
220	3.67	1	1	3	6	41	41	41	48	48	48	6	6	17
221	3.68	1	1	3	6	41	41	40	48	48	48	6	6	17
222	3.70	1	1	3	5	41	41	40	48	48	48	6	6	17
223	3.72	1	1	3	5	41	41	40	48	48	48	6	6	17
224	3.73	1	1	3	5	41	41	40	48	48	48	6	6	17
225	3.75	1	1	3	5	41	41	40	48	48	48	6	6	16
226	3.77	1	1	3	5	41	41	39	48	48	48	6	6	16
227	3.78	1	1	3	5	41	41	39	48	48	48	6	6	16
228	3.80	1	1	3	5	41	41	39	48	48	48	6	6	16
229	3.82	1	1	3	5	41	41	39	48	48	48	6	6	16
230	3.83	1	1	3	5	41	41	39	48	48	48	6	6	16
231	3.85	1	1	3	5	41	41	38	48	48	48	6	6	16
232	3.87	1	1	3	5	41	41	38	48	48	48	6	6	16
233	3.88	1	1	3	5	41	41	38	48	48	48	6	6	16
234	3.90	1	1	3	5	41	41	38	48	48	48	6	6	16
235	3.92	1	1	3	5	41	41	38	48	48	48	6	6	16
236	3.93	1	1	3	5	41	41	38	48	48	48	6	6	16
237	3.95	1	1	3	5	41	41	38	48	48	48	6	6	16
238	3.97	1	1	3	5	41	41	37	48	48	48	6	6	16

239	3.98	1	1	3	5	41	41	37	48	48	48	6	6	16
240	4.00	1	1	3	5	41	41	37	48	48	48	6	6	15
241	4.02	1	1	3	5	41	41	37	48	48	48	6	6	15
242	4.03	1	1	3	5	41	41	37	48	48	48	6	6	15
243	4.05	1	1	3	5	41	41	37	48	48	48	6	6	15
244	4.07	1	1	3	5	41	41	37	48	48	48	6	6	15
245	4.08	1	1	3	5	41	41	37	48	48	48	6	6	15
246	4.10	1	1	3	5	41	41	37	48	48	48	6	6	15
247	4.12	1	1	3	5	41	41	36	48	48	48	6	6	15
248	4.13	1	1	3	5	41	41	36	48	48	48	6	6	15
249	4.15	1	1	3	5	41	41	36	48	48	48	6	6	15
250	4.17	1	1	3	5	41	41	36	48	48	48	6	6	15
251	4.18	1	1	3	5	41	41	36	48	48	48	6	6	15
252	4.20	1	1	3	5	41	41	36	48	48	48	6	6	15
253	4.22	1	1	3	5	41	41	36	48	48	48	6	6	15
254	4.23	1	1	3	5	41	41	36	48	48	48	6	6	15
255	4.25	1	1	3	5	41	41	36	48	48	48	6	6	15
256	4.27	1	1	3	5	41	41	36	48	48	48	6	6	15
257	4.28	1	1	3	5	41	41	36	48	48	48	6	6	15
258	4.30	1	1	3	5	41	41	36	48	48	48	6	6	15
259	4.32	1	1	3	5	41	41	35	48	48	48	6	6	15
260	4.33	1	1	3	5	41	41	35	48	48	48	6	6	15
261	4.35	1	1	3	5	41	41	35	48	48	48	6	6	15
262	4.37	1	1	3	5	41	41	35	48	48	48	6	6	15
263	4.38	1	1	3	5	41	41	35	48	48	48	6	6	15
264	4.40	1	1	3	5	41	41	35	48	48	48	6	6	15
265	4.42	1	1	3	5	41	41	35	48	48	48	6	6	15
266	4.43	1	1	3	5	41	41	35	48	48	48	6	6	15
267	4.45	1	1	3	5	41	41	35	48	48	48	6	6	15
268	4.47	1	1	3	5	41	41	35	48	48	48	6	6	15
269	4.48	1	1	3	5	41	41	35	48	48	48	6	6	15
270	4.50	1	1	3	5	41	41	35	48	48	48	6	6	14
271	4.52	1	1	3	5	41	41	35	48	48	48	6	6	14
272	4.53	1	1	3	5	41	41	35	48	48	48	6	6	14
273	4.55	1	1	3	5	41	41	35	48	48	48	6	6	14
274	4.57	1	1	3	5	41	41	35	48	48	48	6	6	14
275	4.58	1	1	3	5	41	41	35	48	48	48	6	6	14
276	4.60	1	1	3	5	41	41	35	48	48	48	6	6	14
277	4.62	1	1	3	5	41	41	35	48	48	48	6	6	14
278	4.63	1	1	3	5	41	41	35	48	48	48	6	6	14
279	4.65	1	1	3	5	41	41	35	48	48	48	6	6	14
280	4.67	1	1	3	5	41	41	35	48	48	48	6	6	14
281	4.68	1	1	3	5	41	41	34	48	48	48	6	6	14
282	4.70	1	1	3	5	41	41	34	48	48	48	6	6	14
283	4.72	1	1	3	5	41	41	34	48	48	48	6	6	14
284	4.73	1	1	3	5	41	41	34	48	48	48	6	6	14
285	4.75	1	1	3	5	41	41	34	48	48	48	6	6	14
286	4.77	1	1	3	5	41	41	34	48	48	48	6	6	14
287	4.78	1	1	3	5	41	41	34	48	48	48	6	6	14
288	4.80	1	1	3	5	41	41	34	48	48	48	6	6	14
289	4.82	1	1	3	5	41	41	34	48	48	48	6	6	14
290	4.83	1	1	3	5	41	41	34	48	48	48	6	6	14
291	4.85	1	1	3	5	41	41	34	48	48	48	6	6	14
292	4.87	1	1	3	5	41	41	34	48	48	48	6	6	14
293	4.88	1	1	3	5	41	41	34	48	48	48	6	6	14
294	4.90	1	1	3	5	41	41	34	48	48	48	6	6	14
295	4.92	1	1	3	5	41	41	34	48	48	48	6	6	14
296	4.93	1	1	3	5	41	41	34	48	48	48	6	6	14
297	4.95	1	1	3	5	41	41	34	48	48	48	6	6	14
298	4.97	1	1	3	5	41	41	34	48	48	48	6	6	14
299	4.98	1	1	3	5	41	41	34	48	48	48	6	6	14
300	5.00	1	1	3	5	41	41	34	48	48	48	6	6	14