

Evaluation of Performance of NesbittAire Unit Ventilators Equipped with Lumalier UVGI Lamps.

by

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This report evaluates the performance of a NesbittAire Unit Ventilator equipped with a UVGI lamp designed to disinfect the air of a classroom. The system design data and operating parameters are summarized in Table 1. The UVGI lamp selected for this application produces 17.5 watts of UV power and given the 0.28 second exposure time produces a dose of 1151 $\mu\text{W-s}/\text{cm}^2$. This dose would be rated with a UVGI Rating Value (URV) of 11, which is sufficient to disinfect the air of many viruses and bacteria at high rates.

Table 1: System Design Data

System	Nesbitt
Width, in	56
Height, in	14
Length, in	13
Width, cm	142.24
Height, cm	35.56
Length, cm	33.02
Face Area, cm^2	5058.05
Face Area, ft^2	5.44
Face Area, m^2	0.5058
CFM	1250
fpm	230
Q, m^3/min	35.40
Exposure Time, s	0.28
Lamp UV Power, W	17.5
Number of lamps	2
Intensity, $\mu\text{W}/\text{cm}^2$	4064
Dose, $\mu\text{W-s}/\text{cm}^2$	1151
URV	11
arclength, in	16.3
arclength, cm	41.402

Based on the dose rate produced by the UV lamp, Table 2 shows the estimated kill rates for a variety of microorganisms. High kill rates are obtained for a number of critical microbes that may occur in the classroom such as influenza, *Streptococcus*, TB, and cold viruses. It should be noted that although some kill rates are low, as for anthrax and Francisella, these are improbable contaminants in the classroom. It should also be noted that these kill rates are for a single pass through the unit, and that after multiple passes even resistant microbes (i.e. fungal spores) will be disinfected.

Table 2: Kill Rates under UVGI Exposure

Airborne Microbe	Average k cm ² /W-s	Kill Rates %
Adenovirus	0.00030	29
Coxsackievirus	0.00142	80
Echovirus	0.00022	22
Influenza A	0.00119	74
Parvovirus	0.00058	48
Reovirus Type 1	0.00025	25
SARS virus	0.00119	74
Smallpox	0.00145	81
Bacillus anthracis spores	0.00003	4
Clostridium perfringens	0.00017	18
Corynebacterium diphtheriae	0.00068	54
Coxiella burnetti	0.00154	83
Enterobacter cloacae	0.00029	28
Francisella tularensis	0.00015	16
Haemophilus influenzae	0.00066	53
Klebsiella pneumoniae	0.01207	100
Mycobacterium tuberculosis	0.00205	91
Mycobacterium kansasii	0.00036	34
Mycobacterium avium-intra.	0.00041	37
Mycobacterium parafortuitum	0.00110	72
Mycobacterium smegmatis	0.00031	30
Neisseria catarrhalis	0.00052	45
Nocardia asteroides mycelia	0.00008	9
Legionella pneumophila	0.00252	94
Proteus vulgaris	0.00077	59
Pseudomonas aeruginosa	0.00185	88
Rickettsiae prow azeki	0.00029	29
Serratia marcescens	0.00260	95
Staphylococcus aureus	0.00248	94
Streptococcus pyogenes	0.00276	96

Table 3 summarizes the data for a typical classroom and the air exchange rate expected. It is assumed that 15% outside air is provided to the classroom. This data is used to estimate the airborne concentrations of contaminants in the classroom for two microbes, *Mycobacterium tuberculosis* and influenza virus.

Table 3: Input Data for Classroom

Width	35	ft
Length	25	ft
Height	10	ft
W	10.67	m
L	7.62	m
H	3.05	m
Floor Area	875.00	ft2
Floor Area	81.29	m2
Volume	8750.00	ft3
Volume	247.77	m3
Airflow	1250	cfm
Airflow	75000	ft3/hr
Air Change rate	8.57	ACH
Outside Air	15	%
Outside Air	187.5	cfm

Figure 1 shows the estimated concentrations of *Mycobacterium tuberculosis* in the classroom when the release rate is sufficient to cause 99% infections without UVGI. With the UVGI system installed, the airborne concentrations are seen to be considerably reduced.

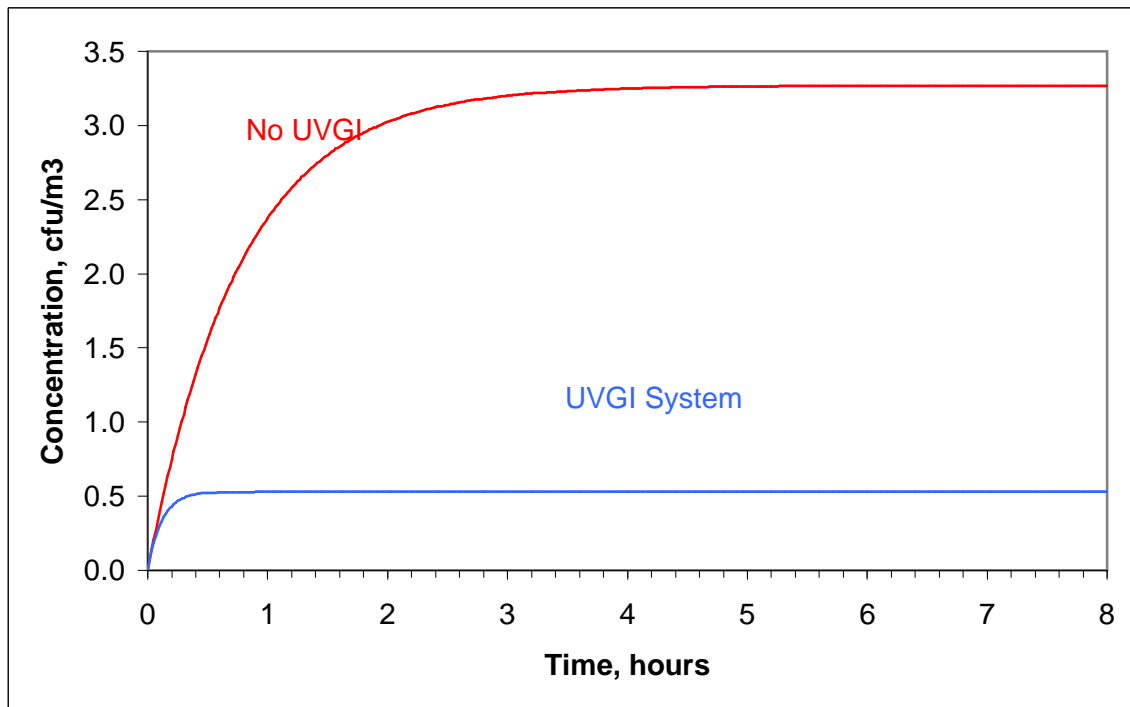


Figure 1: Airborne Concentration of *Mycobacterium tuberculosis* in a model classroom, with and without UVGI system.

Based on the airborne concentrations in Figure 1, the estimated infections caused by *M. tuberculosis* are shown in Figure 2. It can be seen that the estimated infections are greatly reduced, to less than 10%, in this scenario. In actuality, the release rate of *M. tuberculosis* is likely to be far less and the resulting infections would approach zero.

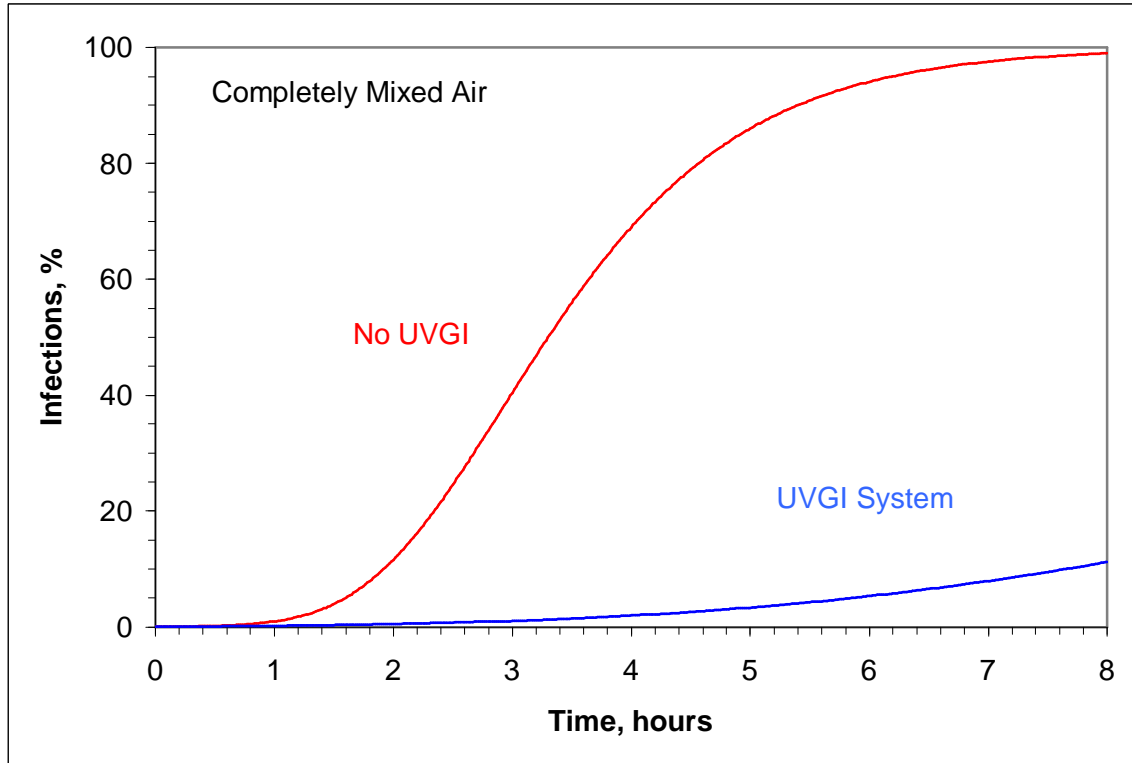


Figure 2: Estimated *M. tuberculosis* infections in a model classroom with and without UVGI.

Figure 3 shows the estimated concentrations of influenza virus in the classroom when the release rate is sufficient to cause 99% infections without UVGI. With the UVGI system installed, the airborne concentrations are seen to be considerably

reduced.

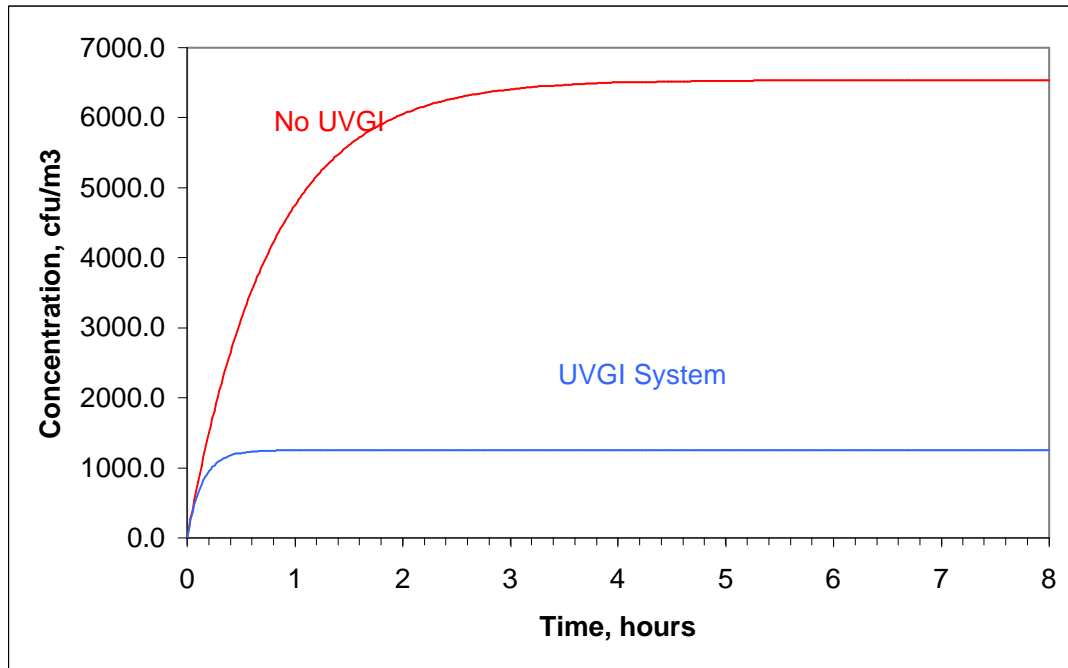


Figure 3: Airborne Concentration of Influenza A virus in a model classroom, with and without UVGI system.

Based on the airborne concentrations in Figure 1, the estimated infections caused by influenza virus are shown in Figure 2. It can be seen that the estimated infections are greatly reduced, to less than 15%, in this scenario. In actuality, the release rate of influenza virus is likely to be far less and the resulting infections would approach zero. Results for other pathogens would be similar and the UVGI system will offer protection against a wide range of indoor contaminants.

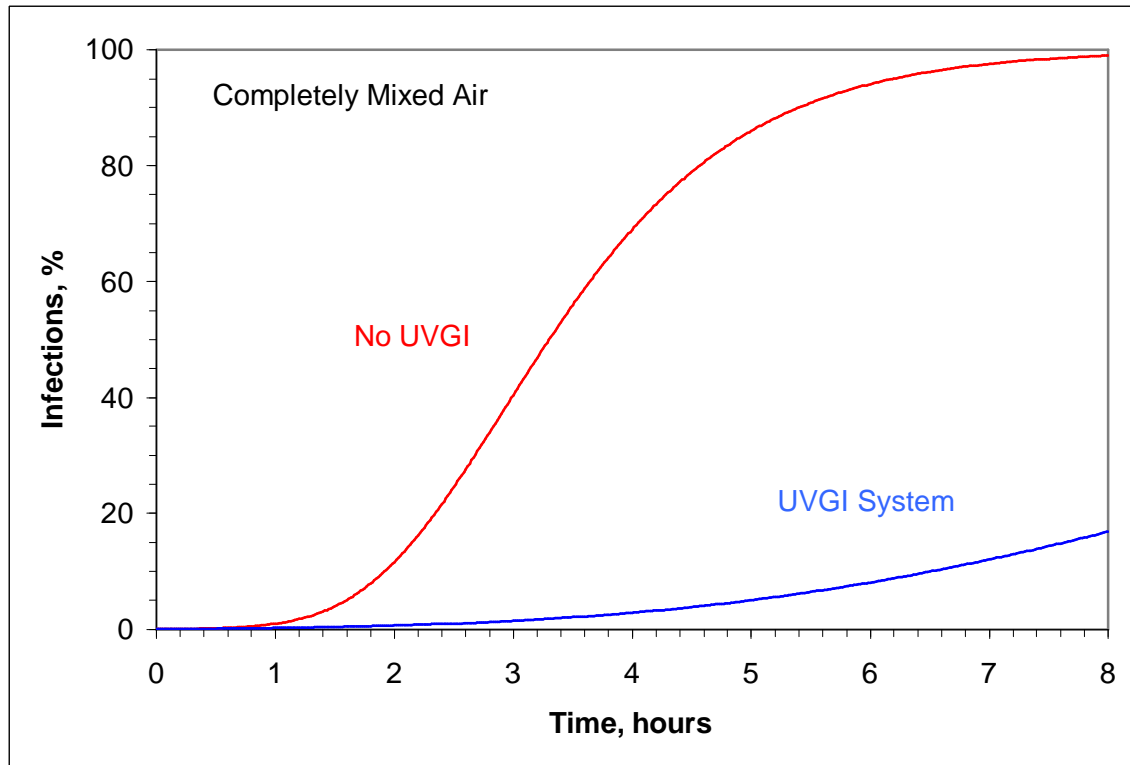


Figure 4: Estimated Influenza infections in a model classroom with and without UVGI.

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