# Performance of the UV24 Unit Against Zoonotic Pathogens

February 1, 2017

By Dr. Wladyslaw Kowalski

For Medical Illumination International

## Contents

# Introduction

The UV24 unit disinfects airborne pathogens using ultraviolet light and employs an airflow of 50 cfm. It is intended for applications in rooms occupied by humans and can also be applied to veterinary environments for the control of zoonotic pathogens. The unit can protect human occupants from zoonotic diseases in rooms that house various types of animals and can protect animals from zoonotic diseases that hail from other animals. The animals for which it is intended to offer protection from airborne diseases include dogs, cats, poultry & birds, rodents and hamsters, horses, swine, cows, rabbits, lizards and snakes. The pathogens that have been identified as being of greatest concern in the veterinary industry include but are not limited to *Microsporum canis*, Canine Distemper virus, Canine Influenza (H2N7), Feline Infectious peritonitis, Feline coronavirus, *Cryptococcus* spp., Feline Rhinotracheotis, Reovirus, *Micrococcus, Staphylococcus aureus* (MRSA), *Pasteurella multocida*, Porcine circovirus, and *Bordetella pertussis*. A complete list of potentially airborne zoonotic pathogens is included for which the UV susceptibility is known and the predicted performance of the UV24 unit against these pathogens is evaluated. Also evaluated are the removal rates of pathogens in a model room of 800 $ft^3$ volume with no outside air. Included for completeness in Appendix A is a list of all zoonotic pathogens which are not airborne.

## Evaluation of Select Zoonotic Pathogens

Table 1 summarizes critical information for the aforestated zoonotic pathogens including ultraviolet (UV) susceptibility, the primary diseases caused, and transmissivity to humans. The affected animal species is identified with a single letter code identified below the table. The Group identifies Viruses (V), Bacteria (B), Fungi (F) and Fungal Spores (FS) with a single letter code. Only one of these select pathogens, *Pasteurella multocida*, has no known UV susceptibility. The UV susceptibilities of the remaining pathogens are taken from Kowalski (2009).

The UV24 unit has an airflow of 50 cfm and produces a UV Dose of 198 J/m$^2$. It also employs a MERV 6 filter. The performance curve for the MERV 6 filter model is based on Kowalski et al (1999) and has been extended into the virus size range (below about 0.1 micron) as shown in Figure 1. The mean diameters of the subject microbes have been used to predict the filter removal rates.

**Table 1: Select Airborne Zoonotic Pathogens**

| PATHOGEN | HOST | GROUP | DISEASE | Mean dia. µm | UV k m$^2$/J | UV D90 J/m$^2$ | Trans to Human |
|---|---|---|---|---|---|---|---|
| Bordetella bronchiseptica | DCR | B | Kennel cough | 0.707 | 0.0364 | 63.258 | Yes |
| Canine Distemper Virus (CDV) | DC | V | Canine distemper | 0.15 | 0.11 | 20.933 | No |
| Canine Influenza H3N2 | DC | V | Flu | 0.098 | 0.101 | 22.798 | No |
| Canine Influenza H3N8 | DE | V | Flu | 0.098 | 0.101 | 22.798 | No |
| Coronavirus | P | V | Infectious bronchitis | 0.113 | 0.01 | 230.26 | Yes |
| Cryptococcus farciminosis | E | F | Cryptococcosis | 4.9 | 0.0167 | 137.88 | Yes |
| Cryptococcus neoformans | DCBEO | F | Cryptococcosis | 4.899 | 0.0167 | 137.88 | Yes |
| Feline Herpesvirus T1 (FVR) | C | V | Colds, fever, rhinotracheitis | 0.18 | 0.1046 | 22.013 | No |
| Feline Infectious Peritonitis virus (FIP) | C | V | Peritonitis, Enteric Coronavirus | 0.11 | 0.0053 | 434.45 | No |
| Micrococcus spp. | P | B | various | 1.2 | 0.0298 | 77.164 | Yes |
| Microsporum canis | DCREO | FS | Dermatophyopsis, ringworm | 2.96 | 0.0096 | 240 | Yes |
| Pasteurella multocida | DCBPRSO | B | Pasteurellosis, fowl cholera | 0.6 | unk | unk | Yes |
| Psittacine Beak and Feather Disease (PBFD) | B | V | Beak & feather infections | 0.055 | 0.007 | 328.94 | No |
| Reovirus | BR | V | Colds, fever, pneumonia | 0.08 | 0.016 | 143.91 | Yes |
| Staphylococcus aureus (MRSA) | DCBPREO | B | MRSA, various infections | 0.866 | 0.596 | 3.8634 | Yes |

D = Dog, C = Cat, R = Rodent, E = Equine, O = Bovine, P = Poultry, Birds, S = Swine

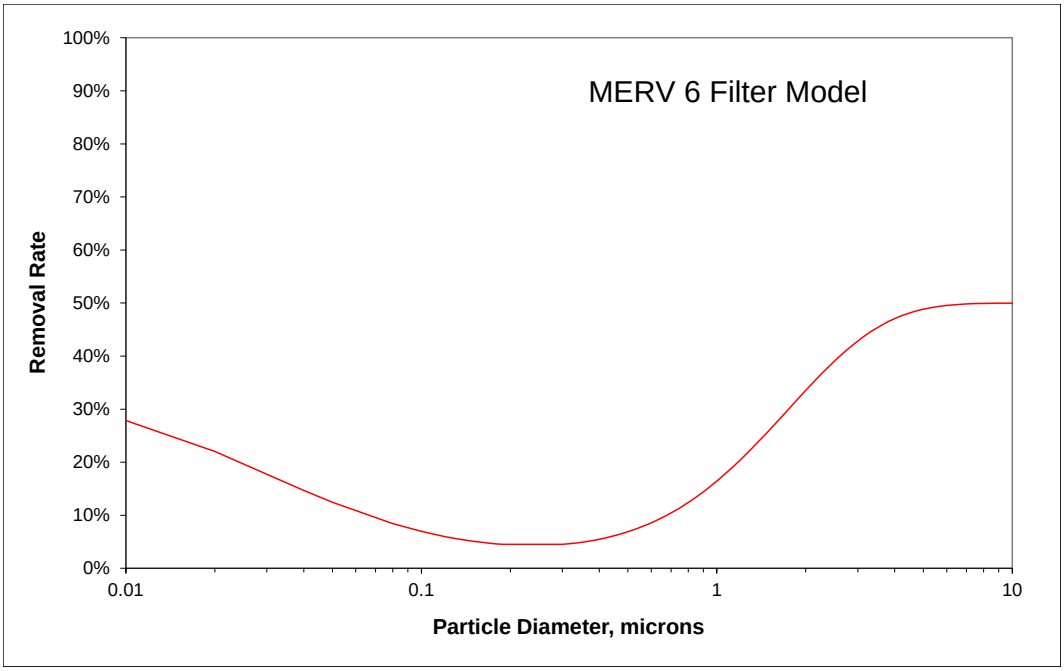


**Figure 1**: MERV 6 Filter Model extended into the virus size range. Per Kowalski et al (1999).

Table 2 summarizes the select pathogens from Table 1 and computes their removal rates from both the MERV 6 filter and the UV lamps, which produce a UV Dose of 198 J/$m^2$. The final column shows the total removal rate in a single pass through the UV24 unit.

Figure 2 illustrates the reduction over time of airborne pathogens in a room of 800 $ft^3$ volume with no outside air. The initial concentration is assumed to be 1000 CFU/$ft^3$. The removal rates represent the combined removal rates of UV and filtration as indicated in Table 2A.

The pathogens in Table 2 are repeated in the following sections where they are analyzed as a group for the subject host animals.

## Table 2: UV24 Kill Rates for Select Airborne Zoonotic Pathogens

| PATHOGEN | Mean Dia. µm | MERV 6 Filtration, % | UV k $m^2/J$ | Single Pass UV Kill Rate, % | Total Removal Rate, % |
|---|---|---|---|---|---|
| Bordetella bronchiseptica | 0.707 | 10.57 | 0.0364 | 99.93 | 99.93 |
| Canine Distemper Virus (CDV) | 0.15 | 5.09 | 0.11 | 100.00 | 100.00 |
| Canine Influenza H3N2 | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Canine Influenza H3N8 | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Coronavirus | 0.113 | 6.29 | 0.01 | 86.19 | 87.06 |
| Cryptococcus farciminosis | 4.9 | 48.72 | 0.0167 | 96.34 | 98.12 |
| Cryptococcus neoformans | 4.9 | 48.72 | 0.0167 | 96.34 | 98.12 |
| Feline Herpesvirus T1 (FVR) | 0.18 | 4.60 | 0.1046 | 100.00 | 100.00 |
| Feline Infectious Peritonitis virus (FIP) | 0.11 | 6.43 | 0.0053 | 64.99 | 67.24 |
| Micrococcus spp. | 1.2 | 20.41 | 0.02984 | 99.73 | 99.78 |
| Microsporum canis | 2.96 | 42.60 | 0.009594 | 85.04 | 91.41 |
| Pasteurella multocida | 0.6 | 8.58 | unk | unk | 8.58 |
| Psittacine Beak and Feather Disease (PBFD) | 0.055 | 11.55 | 0.007 | 74.99 | 77.88 |
| Reovirus | 0.08 | 8.44 | 0.016 | 95.79 | 96.15 |
| Staphylococcus aureus (MRSA) | 0.866 | 13.72 | 0.596 | 100.00 | 100.00 |

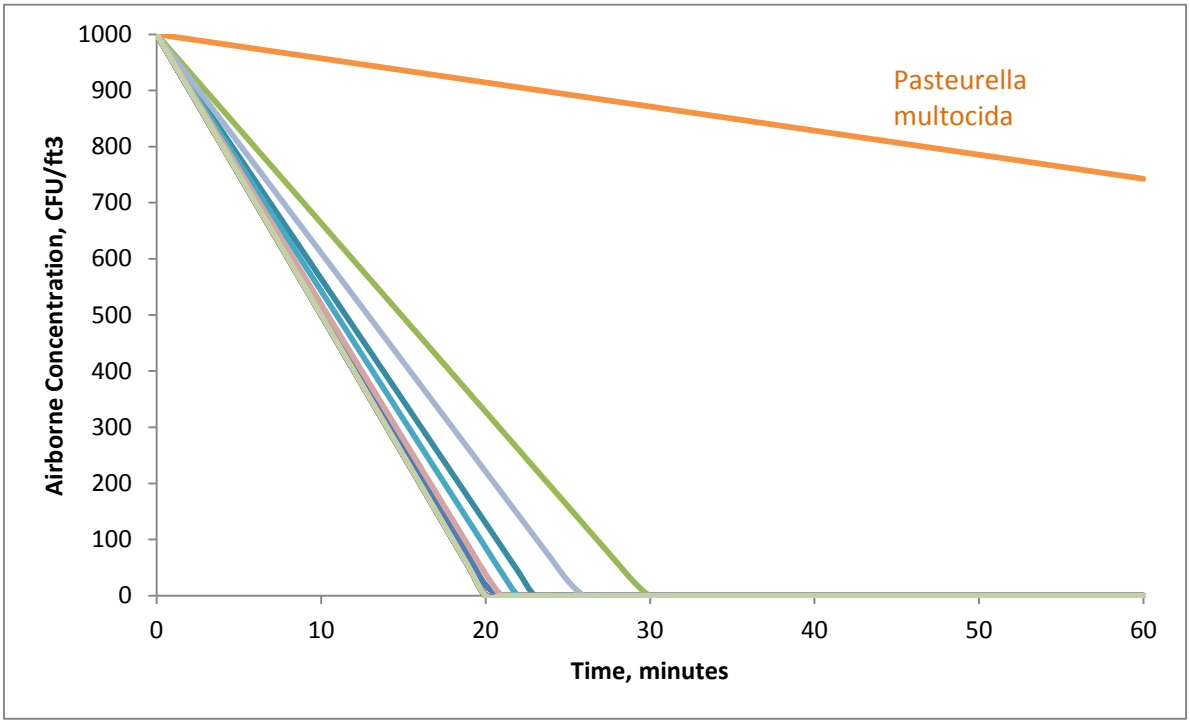


**Figure 2**: Removal of airborne pathogens form a room of 800 ft3 volume by the UV24 unit. *Pasteurella multocida* has no known UV susceptibility and this curve represents filtration only.

## Airborne Diseases of Dogs

Canine diseases form the largest class of pathogens and include many that are transmissible to humans by contact and via the airborne route. Table 3 summarizes all the canine pathogens that are known or suspected to be transmissible by the airborne route. Some of these pathogens do not have a known UV rate constant but they are included in the tables for completeness and only the filter removal rate is given. Table 3A summarizes the calculated removal rates for all the pathogens in Table 3, except where the UV rate constant is unknown. Figure 3 illustrates the removal rates of the pathogens in Table 3A in a model room of 800 $ft^3$ with no outside air and this graph only includes those pathogens with known UV rate constants. It can be observed in Figure 3 that all pathogens are removed to near-zero levels within about one hour.

## Table 3: Potentially Airborne Dog Pathogens and Allergens

| PATHOGEN | GROUP | DISEASE | Mean Dia. µm | UV k $m^2/J$ | UV D90 $J/m^2$ | Trans to Human |
|---|---|---|---|---|---|---|
| Aspergillus spp. | Fungal Spore | Aspergillosis | 3.354 | 0.00058 | 3970 | Yes |
| Avian Influenza A | Virus | flu | 0.098 | 0.101 | 23 | Yes |
| Bacillus anthracis | Bacterial Spore | Anthrax | 1.118 | 0.02702 | 85 | Yes |
| Blastomyces dermatitidis | Fungal Spore | dermatitis | 11 | 0.0165 | 140 | Yes |
| Bordetella bronchiseptica | Bacteria | kennel cough | 0.707 | 0.0364 | 63 | Yes |
| Brachyspira pilosicoli | Bacteria | Gastrointestinal illness | 0.5 | 0.0324 | 71 | No |
| Brucella abortus | Bacteria | Brucellosis, undulant fever | 0.57 | 0.0307 | 75 | Yes |
| Brucella canis | Bacteria | Brucellosis, undulant fever | 0.566 | 0.048 | 48 | Yes |
| Brucella melitensis | Bacteria | Brucellosis | 0.566 | 0.047 | 49 | Yes |
| Brucella suis | Bacteria | Brucellosis | 0.57 | 0.047 | 49 | Yes |
| Burkholderia mallei | Bacteria | Glanders | 0.77 | 0.034 | 68 | Yes |
| Burkholderia pseudomallei | Bacteria | Meliodosis | 0.494 | 0.0344 | 67 | Yes |
| Campylobacter coli | Bacteria | Enteritis, Campylobacteriosis | 2.12 | 0.144 | 16 | Yes |
| Campylobacter jejuni | Bacteria | Enteritis | 2.12 | 0.1444 | 16 | Yes |
| Canine Adenovirus Type 1 (CAdV-1) | Virus | hepatitis | 0.093 | 0.026 | 89 | No |
| Canine Adenovirus Type 2 (CAdV-2) | Virus | kennel cough | 0.093 | 0.018 | 128 | No |
| Canine Calicivirus (CaCV) | Virus | fever, conjunctivitis | 0.034 | 0.0345 | 67 | No |
| Canine Coronavirus | Virus | colds | 0.113 | 0.377 | 6 | No |
| Canine Distemper Virus (CDV) | Virus | Canine distemper | 0.15 | 0.11 | 21 | No |
| Canine Influenza H3N2 | Virus | flu | 0.098 | 0.101 | 23 | No |
| Canine Influenza H3N8 | Virus | flu | 0.098 | 0.101 | 23 | No |
| Canine Norovirus | Virus | gastroenteritis | 0.035 | 0.0304 | 76 | No |
| Canine Parvovirus 2 | Virus | Intestinal, cardiac disease | 0.022 | 0.092 | 25 | No |
| Chlamydophila pneumoniae | Bacteria | Chlamydiosis | 0.283 | 0.039 | 59 | Yes |
| Clostridium botulinum | Bacteria | Botulism | 1.975 | 0.0412 | 56 | Yes |
| Clostridium perfringens | Bacteria | sepsis, toxins, food poisoning | 5 | 0.06 | 38 | Yes |
| Clostridium tetani | Bacteria | tetanus | 5 | 0.04699 | 49 | Yes |
| Coccidioides immitis | Fungal Spore | Coccidioidomycosis | 3.464 | - | - | Yes |
| Coxiella burnettii | Bacteria | Q Fever | 0.283 | 0.1535 | 15 | Yes |
| Cryptococcus neoformans | Fungi | Cryptococcosis | 4.899 | 0.0167 | 138 | Yes |
| Dermatophilus congolensis | Bacteria | dermatophilosis, mud fever | 1 | - | - | No |
| Epidermophyton | Fungi | Dermatophytosis | 8.5 | - | - | Yes |
| Erysipelothrix spp. | Bacteria | Erysipeloid | 1 | - | - | Yes |
| Feline Influenza A (H7N2) | Virus | Flu | 0.10 | 0.101 | 23 | Yes |
| Francisella tularensis | Bacteria | tularemia, pneumonia, fever | 0.2 | 0.009 | 256 | Yes |
| Hantavirus (Hantaan Virus) | Virus | Hemorrhagic Fever | 0.095 | 0.0688 | 33 | Yes |
| Hendra Virus | Virus | Pneumonia | 0.175 | 0.230259 | 10 | Yes |
| Histoplasma capsulatum | Fungal Spore | URD | 2.236 | 0.01645 | 140 | Yes |
| Influenza A virus | Virus | flu, secondary pneumonia | 0.098 | 0.101 | 23 | Yes |
| Leptospira spp. | Spirochete | Leptospirosis | 0.1 | NA | - | Yes |
| Listeria monocytogenes | Bacteria | Listeriosis | 0.707 | 0.0127 | 181 | Yes |
| Louping Ill (LIV) | Virus | Encephalomyelitis | 0.05 | 0.003289 | 700 | Yes |
| Lymphocytic choriomeningitis (LCMV) | Virus | Armstrong's disease | 0.087 | 0.0605 | 38 | Yes |
| Microsporum spp. | Fungal Spore | Dermatophyopsis | 2.96 | - | - | Yes |
| Mycobacterium bovis | Bacteria | Tuberculosis | 0.637 | 0.181 | 13 | Yes |
| Mycobacterium tuberculosis | Bacteria | Tuberculosis | 0.637 | 0.472 | 5 | Yes |
| Nipah virus (Henipah virus) | Virus | respiratory syndrome | 0.175 | 0.328941 | 7 | No |
| Parainfluenza virus | Virus | flu, colds, croup, pneumonia | 0.194 | 0.1086 | 21 | Yes |
| Pneumocystis carinii | Fungal Spore | pneumocystosis | 2 | - | - | Yes |
| Pseudorabies (PRV) | Virus | Aujeszky's Disease Virus (ADV) | 0.194 | 0.0676 | 34 | No |
| Rabies virus | Virus | rabies | 0.07 | 0.219 | 11 | Yes |
| Spirillus minus | Bacteria | Rat Bite Fever | 1 | - | - | No |
| Sporothrix schenckii | Fungal Spore | Sporotrichosis | 6.325 | - | - | Yes |
| Staphylococcus aureus (MRSA) | Bacteria | MRSA, various infections | 0.866 | 0.596 | 4 | Yes |
| Streptobacillus moniliformis | Bacteria | Rat Bite Fever | 0.707 | - | - | No |
| Streptococcus pyogenes | Bacteria | fever | 0.894 | 1.561 | 1 | Yes |
| Swine Influenza | Virus | H1N1 flu | 0.1 | 0.098 | 23 | Yes |
| Trichophyton spp. | Fungal Spore | Dermatophytosis | 7 | 0.00411 | 560 | Yes |
| Yersinia pestis | Bacteria | Bubonic & Pneumonic Plague | 0.707 | 0.106 | 22 | Yes |

## Table 3A: UV24 Removal Rates for Dog Pathogens

| PATHOGEN | Mean Dia. µm | MERV 6 Filtration, % | UV k $m^2/J$ | Single Pass UV Kill Rate, % | Total Removal Rate, % |
|---|---|---|---|---|---|
| Aspergillus spp. | 3.354 | 44.76 | 0.00058 | 10.85 | 50.75 |
| Avian Influenza A | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Bacillus anthracis | 1.118 | 18.79 | 0.02702 | 99.53 | 99.61 |
| Blastomyces dermatitidis | 11 | 50.00 | 0.0165 | 96.19 | 98.09 |
| Bordetella bronchiseptica | 0.707 | 10.57 | 0.0364 | 99.93 | 99.93 |
| Brachyspira pilosicoli | 0.5 | 6.89 | 0.0324 | 99.84 | 99.85 |
| Brucella abortus | 0.57 | 8.05 | 0.0307 | 99.77 | 99.79 |
| Brucella canis | 0.566 | 7.98 | 0.048 | 99.99 | 99.99 |
| Brucella melitensis | 0.566 | 7.98 | 0.047 | 99.99 | 99.99 |
| Brucella suis | 0.57 | 8.05 | 0.047 | 99.99 | 99.99 |
| Burkholderia mallei | 0.77 | 11.80 | 0.034 | 99.88 | 99.89 |
| Burkholderia pseudomallei | 0.494 | 6.80 | 0.0344 | 99.89 | 99.90 |
| Campylobacter coli | 2.12 | 35.03 | 0.144 | 100.00 | 100.00 |
| Campylobacter jejuni | 2.12 | 35.03 | 0.1444 | 100.00 | 100.00 |
| Canine Adenovirus Type 1 (CAdV-1) | 0.093 | 7.41 | 0.026 | 99.42 | 99.46 |
| Canine Adenovirus Type 2 (CAdV-2) | 0.093 | 7.41 | 0.018 | 97.17 | 97.38 |
| Canine Calicivirus (CaCV) | 0.034 | 16.39 | 0.0345 | 99.89 | 99.91 |
| Canine Coronavirus | 0.113 | 6.29 | 0.377 | 100.00 | 100.00 |
| Canine Distemper Virus (CDV) | 0.15 | 5.09 | 0.11 | 100.00 | 100.00 |
| Canine Influenza H3N2 | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Canine Influenza H3N8 | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Canine Norovirus | 0.035 | 16.08 | 0.0304 | 99.76 | 99.80 |
| Canine Parvovirus 2 | 0.022 | 21.04 | 0.092 | 100.00 | 100.00 |
| Chlamydophila pneumoniae | 0.283 | 4.42 | 0.039 | 99.96 | 99.96 |
| Clostridium botulinum | 1.975 | 33.20 | 0.0412 | 99.97 | 99.98 |
| Clostridium perfringens | 5 | 48.83 | 0.06 | 100.00 | 100.00 |
| Clostridium tetani | 5 | 48.83 | 0.04699 | 99.99 | 100.00 |
| Coccidioides immitis | 3.464 | 45.25 | - | - | - |
| Coxiella burnettii | 0.283 | 4.42 | 0.1535 | 100.00 | 100.00 |
| Cryptococcus neoformans | 4.899 | 48.72 | 0.0167 | 96.34 | 98.12 |
| Dermatophilus congolensis | 1 | 16.43 | - | - | - |
| Epidermophyton | 8.5 | 49.96 | - | - | - |
| Erysipelothrix spp. | 1 | 16.43 | - | - | - |
| Feline Influenza A (H7N2) | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Francisella tularensis | 0.2 | 4.43 | 0.009 | 83.17 | 83.91 |
| Hantavirus (Hantaan Virus) | 0.095 | 7.28 | 0.0688 | 100.00 | 100.00 |
| Hendra Virus | 0.175 | 4.67 | 0.2303 | 100.00 | 100.00 |
| Histoplasma capsulatum | 2.236 | 36.37 | 0.0165 | 96.15 | 97.55 |
| Influenza A virus | 0.098 | 7.09 | 0.1010 | 100.00 | 100.00 |
| Leptospira spp. | 0.1 | 6.97 | - | - | - |
| Listeria monocytogenes | 0.707 | 10.57 | 0.0127 | 91.91 | 92.77 |
| Louping Ill (LIV) | 0.05 | 12.45 | 0.0033 | 47.86 | 54.35 |
| Lymphocytic choriomeningitis (LCMV) | 0.087 | 7.85 | 0.0605 | 100.00 | 100.00 |
| Microsporum spp. | 2.96 | 42.60 | - | - | - |
| Mycobacterium bovis | 0.637 | 9.25 | 0.181 | 100.00 | 100.00 |
| Mycobacterium tuberculosis | 0.637 | 9.25 | 0.472 | 100.00 | 100.00 |
| Nipah virus (Henipah virus) | 0.175 | 4.67 | 0.328940728 | 100.00 | 100.00 |
| Parainfluenza virus | 0.194 | 4.47 | 0.1086 | 100.00 | 100.00 |
| Pneumocystis carinii | 2 | 33.53 | - | - | - |
| Pseudorabies (PRV) | 0.194 | 4.47 | 0.0676 | 100.00 | 100.00 |
| Rabies virus | 0.07 | 9.46 | 0.219 | 100.00 | 100.00 |
| Spirillus minus | 1 | 16.43 | - | - | - |
| Sporothrix schenckii | 6.325 | 49.66 | - | - | - |
| Staphylococcus aureus (MRSA) | 0.866 | 13.72 | 0.596 | 100.00 | 100.00 |
| Streptobacillus moniliformis | 0.707 | 10.57 | - | - | - |
| Streptococcus pyogenes | 0.894 | 14.28 | 1.561 | 100.00 | 100.00 |
| Swine Influenza | 0.1 | 6.97 | 0.098 | 100.00 | 100.00 |
| Trichophyton spp. | 7 | 49.82 | 0.00411 | 55.68 | 77.76 |
| Yersinia pestis | 0.707 | 10.57 | 0.106 | 100.00 | 100.00 |

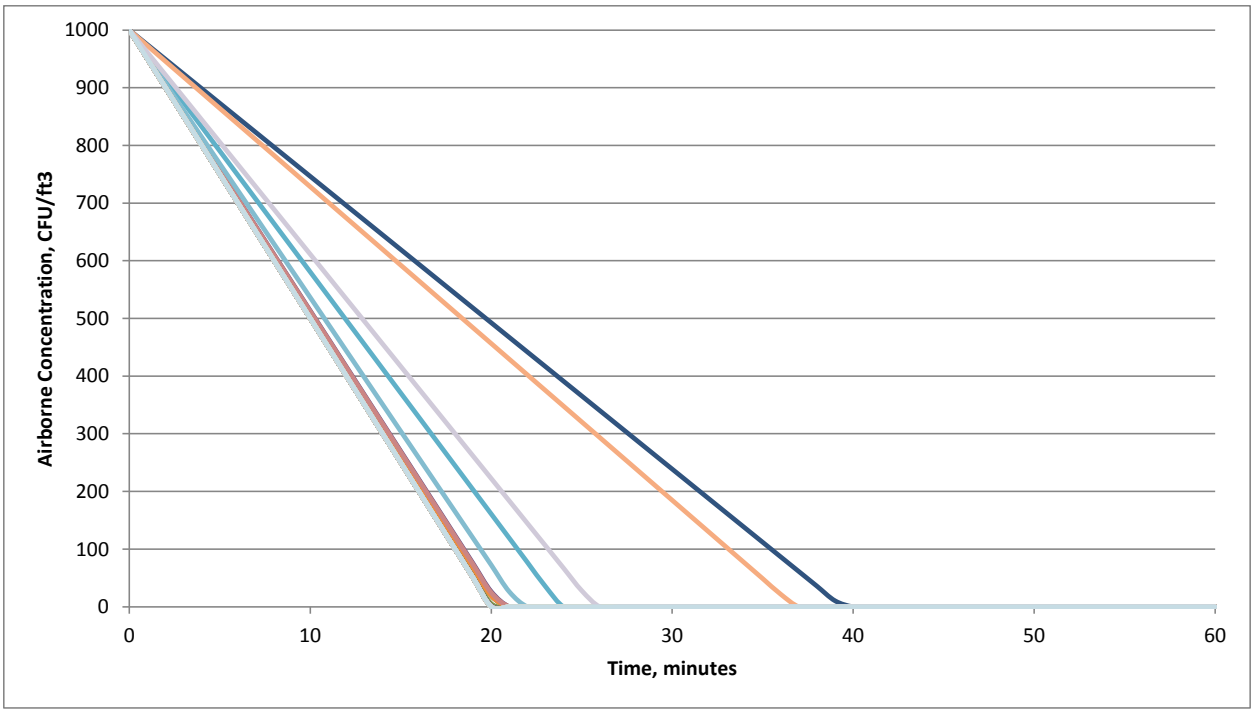


**Figure 3**: Removal of Canine pathogens by the UV24 unit in a room of 800 $ft^3$ volume with no outside air. Only microbes from Table 3A with known UV rate constants are included.

## Airborne Diseases of Cats

Feline diseases form the next largest group of zoonotic diseases and include many that are potentially airborne and that can transmit to humans. Table 4 summarizes all of the cat pathogens and allergens that are known or suspected to transmit by the airborne route.

**Table 4: Potentially Airborne Cat Pathogens and Allergens**

| PATHOGEN | GROUP | DISEASE | Mean Dia. µm | UV k $m^2/J$ | UV D90 $J/m^2$ | Trans to Human |
|---|---|---|---|---|---|---|
| Aspergillus spp. | Fungal Spore | Aspergillosis | 3.354 | 0.00058 | 3970 | Yes |
| Avian Influenza A | Virus | flu | 0.098 | 0.101 | 23 | Yes |
| Bacillus anthracis | Bacterial Spore | Anthrax | 1.118 | 0.02702 | 85 | Yes |
| Bordetella bronchiseptica | Bacteria | kennel cough | 0.707 | 0.0364 | 63 | Yes |
| Brachyspira pilosicoli | Bacteria | Gastrointestinal illness | 0.5 | 0.0324 | 71 | No |
| Burkholderia mallei | Bacteria | Glanders | 0.77 | 0.034 | 68 | Yes |
| Burkholderia pseudomallei | Bacteria | Meliodosis | 0.494 | 0.0344 | 67 | Yes |
| Campylobacter coli | Bacteria | Enteritis, Campylobacteriosis | 2.12 | 0.144 | 16 | Yes |
| Campylobacter jejuni | Bacteria | Enteritis | 2.12 | 0.1444 | 16 | Yes |
| Canine Distemper Virus (CDV) | Virus | Canine distemper | 0.15 | 0.11 | 21 | No |
| Canine Influenza H3N2 | Virus | flu | 0.098 | 0.101 | 23 | No |
| Canine Parvovirus 2 | Virus | Intestinal, cardiac disease | 0.022 | 0.092 | 25 | No |
| Chlamydophila felis | Bacteria | Chlamydiosis | 0.283 | 0.0384 | 60 | No |
| Clostridium botulinum | Bacteria | Botulism | 1.975 | 0.0412 | 56 | Yes |
| Clostridium tetani | Bacteria | tetanus | 5 | 0.04699 | 49 | Yes |
| Coccidioides immitis | Fungal Spore | Coccidioidomycosis | 3.464 | - | - | Yes |
| Cowpox | Virus | cow pox | 0.173 | 0.135 | 17 | Yes |
| Coxiella burnettii | Bacteria | Q Fever | 0.283 | 0.1535 | 15 | Yes |
| Cryptococcus neoformans | Fungi | Cryptococcosis | 4.899 | 0.0167 | 138 | Yes |
| Epidermophyton | Fungi | Dermatophytosis | 8.5 | - | - | Yes |
| Erysipelothrix spp. | Bacteria | Erysipeloid | 1 | - | - | Yes |
| Feline Calicivirus (FeCV) | Virus | URD, pneumonia | 0.037 | 0.0345 | 67 | No |
| Feline Distemper (Feline Parvovirus, FPV) | Virus | Distemper, Panleukopenia | 0.022 | 0.092 | 25 | No |
| Feline Herpesvirus T1 (Rhinotracheitis, FVR) | Virus | colds, fever | 0.18 | 0.1046 | 22 | No |
| Feline Infectious Peritonitis virus (FIP) | Virus | Peritonitis, Enteric Coronavirus | 0.11 | 0.0053 | 434 | No |
| Feline Influenza A (H7N2) | Virus | Flu | 0.10 | 0.101 | 23 | Yes |
| Feline Panleukopenia (Picornavirus) (FPV) | Virus | Panleukopenia | 0.037 | 0.066 | 35 | No |
| Francisella tularensis | Bacteria | tularemia, pneumonia, fever | 0.2 | 0.009 | 256 | Yes |
| Hantavirus (Hantaan Virus) | Virus | Hemorrhagic Fever | 0.095 | 0.0688 | 33 | Yes |
| Hendra Virus | Virus | Pneumonia | 0.175 | 0.230259 | 10 | Yes |
| Histoplasma capsulatum | Fungal Spore | URD | 2.236 | 0.01645 | 140 | Yes |
| Influenza A virus | Virus | flu, secondary pneumonia | 0.098 | 0.101 | 23 | Yes |
| Leptospira spp. | Spirochete | Leptospirosis | 0.1 | NA | - | Yes |
| Listeria monocytogenes | Bacteria | Listeriosis | 0.707 | 0.0127 | 181 | Yes |
| Microsporum spp. | Fungal Spore | Dermatophyopsis | 2.96 | - | - | Yes |
| Mycobacterium avium | Bacteria | Paratuberculosis, Johne's Disease | 1.118 | 0.04387 | 52 | Yes |
| Mycobacterium bovis | Bacteria | Tuberculosis | 0.637 | 0.181 | 13 | Yes |
| Mycobacterium tuberculosis | Bacteria | Tuberculosis | 0.637 | 0.472 | 5 | Yes |
| Mycoplasma spp. | Bacteria | infectious anemia, eye disease | 0.177 | 0.284 | 8 | Yes |
| Nipah virus (Henipah virus) | Virus | respiratory syndrome | 0.175 | 0.328941 | 7 | No |
| Pneumocystis carinii | Fungal Spore | pneumocystosis | 2 | - | - | Yes |
| Pseudorabies (PRV) | Virus | Aujeszky's Disease Virus (ADV) | 0.194 | 0.0676 | 34 | No |
| Rabies virus | Virus | rabies | 0.07 | 0.219 | 11 | Yes |
| Spirillus minus | Bacteria | Rat Bite Fever | 1 | - | - | No |
| Sporothrix schenckii | Fungal Spore | Sporotrichosis | 6.325 | - | - | Yes |
| Staphylococcus aureus (MRSA) | Bacteria | MRSA, various infections | 0.866 | 0.596 | 4 | Yes |
| Streptobacillus moniliformis | Bacteria | Rat Bite Fever | 0.707 | - | - | No |
| Streptococcus pyogenes | Bacteria | fever | 0.894 | 1.561 | 1 | Yes |
| Swine Influenza | Virus | H1N1 flu | 0.1 | 0.098 | 23 | Yes |
| Trichophyton spp. | Fungal Spore | Dermatophytosis | 7 | 0.00411 | 560 | Yes |
| Yersinia pestis | Bacteria | Bubonic & Pneumonic Plague | 0.707 | 0.106 | 22 | Yes |

## Table 4A: UV24 Removal Rates for Cat Pathogens

| PATHOGEN | Mean Dia. μm | MERV 6 Filtration, % | UV k $m^2/J$ | Single Pass UV Kill Rate, % | Total Removal Rate, % |
|---|---|---|---|---|---|
| Aspergillus spp. | 3.354 | 44.76 | 0.00058 | 10.85 | 50.75 |
| Avian Influenza A | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Bacillus anthracis | 1.118 | 18.79 | 0.02702 | 99.53 | 99.61 |
| Bordetella bronchiseptica | 0.707 | 10.57 | 0.0364 | 99.93 | 99.93 |
| Brachyspira pilosicoli | 0.5 | 6.89 | 0.0324 | 99.84 | 99.85 |
| Burkholderia mallei | 0.77 | 11.80 | 0.034 | 99.88 | 99.89 |
| Burkholderia pseudomallei | 0.494 | 6.80 | 0.0344 | 99.89 | 99.90 |
| Campylobacter coli | 2.12 | 35.03 | 0.144 | 100.00 | 100.00 |
| Campylobacter jejuni | 2.12 | 35.03 | 0.1444 | 100.00 | 100.00 |
| Canine Distemper Virus (CDV) | 0.15 | 5.09 | 0.11 | 100.00 | 100.00 |
| Canine Influenza H3N2 | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Canine Parvovirus 2 | 0.022 | 21.04 | 0.092 | 100.00 | 100.00 |
| Chlamydophila felis | 0.283 | 4.42 | 0.0384 | 99.95 | 99.95 |
| Clostridium botulinum | 1.975 | 33.20 | 0.0412 | 99.97 | 99.98 |
| Clostridium tetani | 5 | 48.83 | 0.04699 | 99.99 | 100.00 |
| Coccidioides immitis | 3.464 | 45.25 | - | - | - |
| Cowpox | 0.173 | 4.69 | 0.135 | 100.00 | 100.00 |
| Coxiella burnettii | 0.283 | 4.42 | 0.1535 | 100.00 | 100.00 |
| Cryptococcus neoformans | 4.899 | 48.72 | 0.0167 | 96.34 | 98.12 |
| Epidermophyton | 8.5 | 49.96 | - | - | - |
| Erysipelothrix spp. | 1 | 16.43 | - | - | - |
| Feline Calicivirus (FeCV) | 0.037 | 15.49 | 0.0345 | 99.89 | 99.91 |
| Feline Distemper (Feline Parvovirus, FPV) | 0.022 | 21.04 | 0.092 | 100.00 | 100.00 |
| Feline Herpesvirus T1 (Rhinotracheitis, FVR) | 0.18 | 4.60 | 0.1046 | 100.00 | 100.00 |
| Feline Infectious Peritonitis virus (FIP) | 0.11 | 6.43 | 0.0053 | 64.99 | 67.24 |
| Feline Influenza A (H7N2) | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Feline Panleukopenia (Picornavirus) (FPV) | 0.037 | 15.49 | 0.066 | 100.00 | 100.00 |
| Francisella tularensis | 0.2 | 4.43 | 0.009 | 83.17 | 83.91 |
| Hantavirus (Hantaan Virus) | 0.095 | 7.28 | 0.0688 | 100.00 | 100.00 |
| Hendra Virus | 0.175 | 4.67 | 0.23026 | 100.00 | 100.00 |
| Histoplasma capsulatum | 2.236 | 36.37 | 0.01645 | 96.15 | 97.55 |
| Influenza A virus | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Leptospira spp. | 0.1 | 6.97 | - | - | - |
| Listeria monocytogenes | 0.707 | 10.57 | 0.0127 | 91.91 | 92.77 |
| Microsporum spp. | 2.96 | 42.60 | - | - | - |
| Mycobacterium avium | 1.118 | 18.79 | 0.04387 | 99.98 | 99.99 |
| Mycobacterium bovis | 0.637 | 9.25 | 0.181 | 100.00 | 100.00 |
| Mycobacterium tuberculosis | 0.637 | 9.25 | 0.472 | 100.00 | 100.00 |
| Mycoplasma spp. | 0.177 | 4.64 | 0.284 | 100.00 | 100.00 |
| Nipah virus (Henipah virus) | 0.175 | 4.67 | 0.32894 | 100.00 | 100.00 |
| Pneumocystis carinii | 2 | 33.53 | - | - | - |
| Pseudorabies (PRV) | 0.194 | 4.47 | 0.0676 | 100.00 | 100.00 |
| Rabies virus | 0.07 | 9.46 | 0.219 | 100.00 | 100.00 |
| Spirillus minus | 1 | 16.43 | - | - | - |
| Sporothrix schenckii | 6.325 | 49.66 | - | - | - |
| Staphylococcus aureus (MRSA) | 0.866 | 13.72 | 0.596 | 100.00 | 100.00 |
| Streptobacillus moniliformis | 0.707 | 10.57 | - | - | - |
| Streptococcus pyogenes | 0.894 | 14.28 | 1.561 | 100.00 | 100.00 |
| Swine Influenza | 0.1 | 6.97 | 0.098 | 100.00 | 100.00 |
| Trichophyton spp. | 7 | 49.82 | 0.00411 | 55.68 | 77.76 |
| Yersinia pestis | 0.707 | 10.57 | 0.106 | 100.00 | 100.00 |

Table 4A summarizes the calculated removal rates for all the pathogens in Table 4, except where the UV rate constant is unknown. Figure 4 illustrates the removal rates of the pathogens in Table 4A in a model room of 800 $ft^3$ with no outside air and this graph only includes those pathogens with known UV rate constants. It can be observed in Figure 4 that all pathogens are removed to near-zero levels within about one hour.

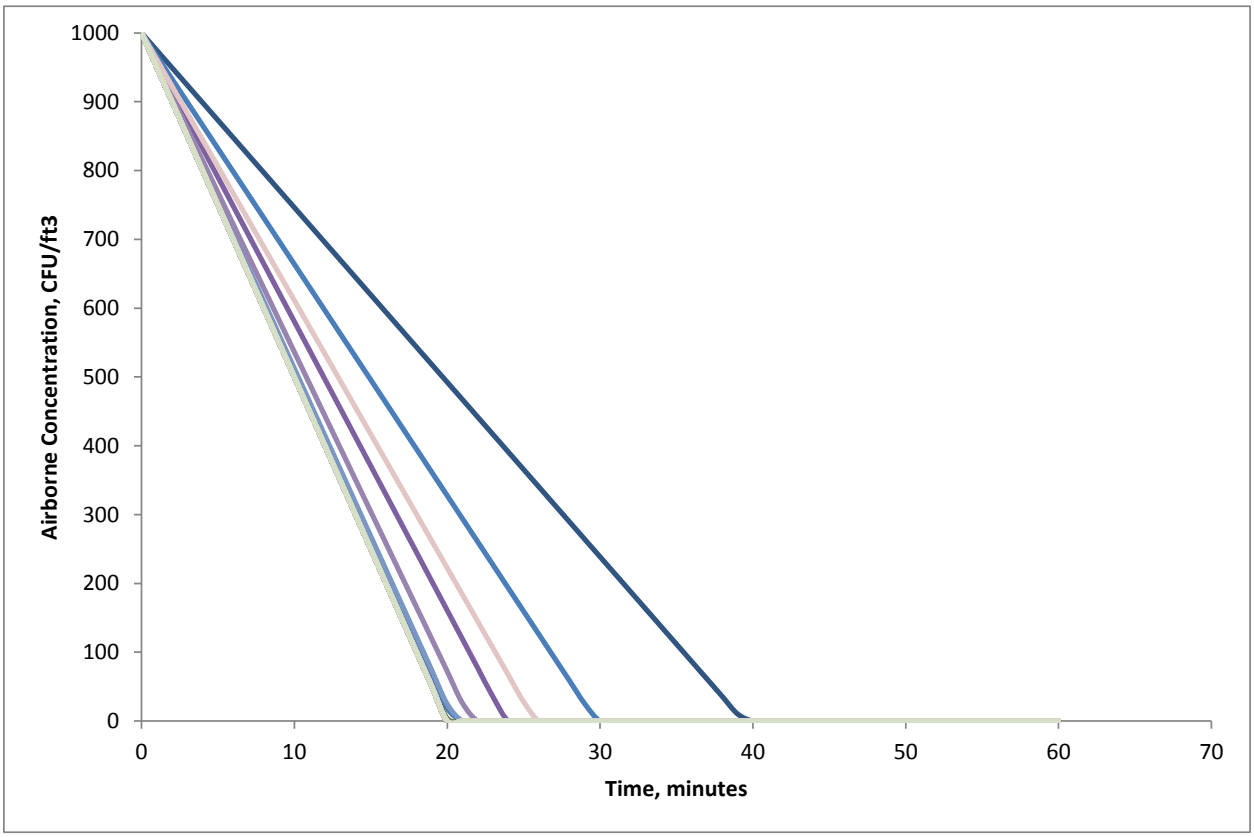


**Figure 4**: Removal of Feline pathogens by the UV24 unit in a room of 800 $ft^3$ volume with no outside air. Only microbes from Table 4A with known UV rate constants are included.

# Airborne Diseases of Birds and Poultry

Table 5 lists all of the potentially airborne zoonotic pathogens of birds (pet birds) and poultry. Table 5A summarizes the calculated removal rates for all the pathogens in Table 5, except where the UV rate constant is unknown. Figure 5 illustrates the removal rates of the pathogens in Table 4A in a model room of 800 $ft^3$ with no outside air and this graph only includes those pathogens with known UV rate constants. It can be observed in Figure 5 that all pathogens are removed to near-zero levels within about one hour.

**Table 5: Potentially Airborne Bird & Poultry Pathogens and Allergens**

| PATHOGEN or DISEASE | GROUP | DISEASE | Mean dia. µm | UV k $m^2/J$ | UV D90 $J/m^2$ | Trans to Human |
|---|---|---|---|---|---|---|
| Aspergillus spp. | Fungal Spore | Aspergillosis | 3.354 | 0.00058 | 3970 | Yes |
| Avian Adenovirus (FAV) | Virus | respiratory disease, bronchitis | 0.08 | 0.0108 | 213 | No |
| Avian Encephalomyelitis Virus | Virus | Encephalomyelitis | 0.023 | 0.02303 | 100 | No |
| Avian Influenza A | Virus | flu | 0.098 | 0.101 | 23 | Yes |
| Avian Leukosis virus (RSA) | Virus | leukosis | 0.107 | 0.00365 | 631 | No |
| Avian metapneumovirus | Virus | turkey rhinotracheitis | 0.1 | - | - | No |
| Avian Sarcoma virus | Virus | sarcoma | 0.098 | 0.0105 | 219 | No |
| Bordetella avium | Bacteria | Bordetellosis | 0.7 | 0.3838 | 6 | No |
| Campylobacter jejuni | Bacteria | Enteritis | 2.12 | 0.1444 | 16 | Yes |
| Canary Pox Virus | Virus | pox | 0.24 | 0.1439 | 16 | No |
| Candida | Fungi | Candidiasis | 4.899 | 0.01 | 230 | Yes |
| Chlamydophila caviae (formerly C.psittaci) | Bacteria | Psittacosis, parrot fever | 0.283 | 0.039 | 59 | Yes |
| Clostridium botulinum | Bacteria | Botulism | 1.975 | 0.0412 | 56 | Yes |
| Clostridium perfringens | Bacteria | sepsis, toxins, food poisoning | 5 | 0.06 | 38 | Yes |
| Coronavirus | Virus | Infectious bronchitis | 0.113 | 0.01 | 230 | Yes |
| Cryptococcus neoformans | Fungi | Cryptococcosis | 4.899 | 0.0167 | 138 | Yes |
| Feline Influenza A (H7N2) | Virus | Flu | 0.10 | 0.101 | 23 | Yes |
| Fowlpox virus (Avian poxvirus) | Virus | fow lpox | 0.24 | 0.1396 | 16 | Yes |
| Histoplasma capsulatum | Fungal Spore | URD | 2.236 | 0.01645 | 140 | Yes |
| Infectious Bronchitis Virus (IBV) | Virus | bronchitis | 0.113 | 0.2424 | 9 | No |
| Infectious Laryngotracheitis (Psittacid herpes) | Virus | respiratory disease | 0.18 | 0.1151 | 20 | No |
| Influenza A virus | Virus | flu, secondary pneumonia | 0.098 | 0.101 | 23 | Yes |
| Marek's Disease Virus (Herpesvirus) | Virus | Marek's disease, ILT | 0.18 | 0.06325 | 36 | No |
| Mycobacterium avium | Bacteria | Paratuberculosis, Johne's Disease | 1.118 | 0.04387 | 52 | Yes |
| Mycoplasma gallisepticum | Bacteria | respiratory disease | 0.177 | 0.284 | 8 | No |
| Mycoplasma spp. | Bacteria | infectious anemia, eye disease | 0.177 | 0.284 | 8 | Yes |
| Mycoplasma synoviae | Bacteria | Synovitis | 0.177 | 0.284 | 8 | No |
| Newcastle Disease Virus (NDV) | Virus | NDV | 0.212 | 0.1636 | 14 | Yes |
| Ornithobacterium rhinotracheale (ORT) | Bacteria | bacterial infection | 0.64 | - | - | No |
| Papilloma virus | Virus | w art-like tumors | 0.055 | 0.0256 | 90 | No |
| Polyomavirus | Virus | paralysis, diarrhea | 0.0424 | 0.00408 | 564 | No |
| Pseudomonas aeruginosa | Bacteria | infection | 0.494 | 0.128 | 18 | Yes |
| Psittacine Beak and Feather Disease (PBFD) | Virus | beak & feather infections | 0.055 | 0.007 | 329 | No |
| Reovirus | Virus | colds, fever, pneumonia | 0.08 | 0.016 | 144 | Yes |
| Salmonella enteritidis | Bacteria | Salmonellosis | 0.81 | 0.221 | 10 | Yes |
| Salmonella typhi | Bacteria | Salmonellosis | 0.81 | 0.1467 | 16 | Yes |
| Staphylococcus aureus (MRSA) | Bacteria | MRSA, various infections | 0.866 | 0.596 | 4 | Yes |

## Table 5A: UV24 Removal Rates for Bird Pathogens

| PATHOGEN | Mean Dia. µm | MERV 6 Filtration, % | UV k $m^2/J$ | Single Pass UV Kill Rate, % | Total Removal Rate, % |
|---|---|---|---|---|---|
| Aspergillus spp. | 3.354 | 44.76 | 0.00058 | 10.85 | 50.75 |
| Avian Adenovirus (FAV) | 0.08 | 8.44 | 0.0108 | 88.22 | 89.21 |
| Avian Encephalomyelitis Virus | 0.023 | 20.57 | 0.02303 | 98.95 | 99.17 |
| Avian Influenza A | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Avian Leukosis virus (RSA) | 0.107 | 6.58 | 0.00365 | 51.46 | 54.65 |
| Avian metapneumovirus | 0.1 | 6.97 | - | - | - |
| Avian Sarcoma virus | 0.098 | 7.09 | 0.0105 | 87.49 | 88.38 |
| Bordetella avium | 0.7 | 10.44 | 0.3838 | 100.00 | 100.00 |
| Campylobacter jejuni | 2.12 | 35.03 | 0.1444 | 100.00 | 100.00 |
| Canary Pox Virus | 0.24 | 4.31 | 0.1439 | 100.00 | 100.00 |
| Candida | 4.899 | 48.72 | 0.01 | 86.19 | 92.92 |
| Chlamydophila caviae (formerly C.psittaci) | 0.283 | 4.42 | 0.039 | 99.96 | 99.96 |
| Clostridium botulinum | 1.975 | 33.20 | 0.0412 | 99.97 | 99.98 |
| Clostridium perfringens | 5 | 48.83 | 0.06 | 100.00 | 100.00 |
| Coronavirus | 0.113 | 6.29 | 0.01 | 86.19 | 87.06 |
| Cryptococcus neoformans | 4.899 | 48.72 | 0.0167 | 96.34 | 98.12 |
| Feline Influenza A (H7N2) | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Fowlpox virus (Avian poxvirus) | 0.24 | 4.31 | 0.1396 | 100.00 | 100.00 |
| Histoplasma capsulatum | 2.236 | 36.37 | 0.01645 | 96.15 | 97.55 |
| Infectious Bronchitis Virus (IBV) | 0.113 | 6.29 | 0.2424 | 100.00 | 100.00 |
| Infectious Laryngotracheitis (Psittacid herpes) | 0.18 | 4.60 | 0.1151 | 100.00 | 100.00 |
| Influenza A virus | 0.098 | 7.09 | 0.101 | 100.00 | 100.00 |
| Marek's Disease Virus (Herpesvirus) | 0.18 | 4.60 | 0.06325 | 100.00 | 100.00 |
| Mycobacterium avium | 1.118 | 18.79 | 0.04387 | 99.98 | 99.99 |
| Mycoplasma gallisepticum | 0.177 | 4.64 | 0.284 | 100.00 | 100.00 |
| Mycoplasma spp. | 0.177 | 4.64 | 0.284 | 100.00 | 100.00 |
| Mycoplasma synoviae | 0.177 | 4.64 | 0.284 | 100.00 | 100.00 |
| Newcastle Disease Virus (NDV) | 0.212 | 4.36 | 0.1636 | 100.00 | 100.00 |
| Ornithobacterium rhinotracheale (ORT) | 0.64 | 9.31 | - | - | - |
| Papilloma virus | 0.055 | 11.55 | 0.0256 | 99.37 | 99.44 |
| Polyomavirus | 0.0424 | 14.08 | 0.00408 | 55.42 | 61.70 |
| Pseudomonas aeruginosa | 0.494 | 6.80 | 0.128 | 100.00 | 100.00 |
| Psittacine Beak and Feather Disease (PBFD) | 0.055 | 11.55 | 0.007 | 74.99 | 77.88 |
| Reovirus | 0.08 | 8.44 | 0.016 | 95.79 | 96.15 |
| Salmonella enteritidis | 0.81 | 12.59 | 0.221 | 100.00 | 100.00 |
| Salmonella typhi | 0.81 | 12.59 | 0.1467 | 100.00 | 100.00 |
| Staphylococcus aureus (MRSA) | 0.866 | 13.72 | 0.596 | 100.00 | 100.00 |

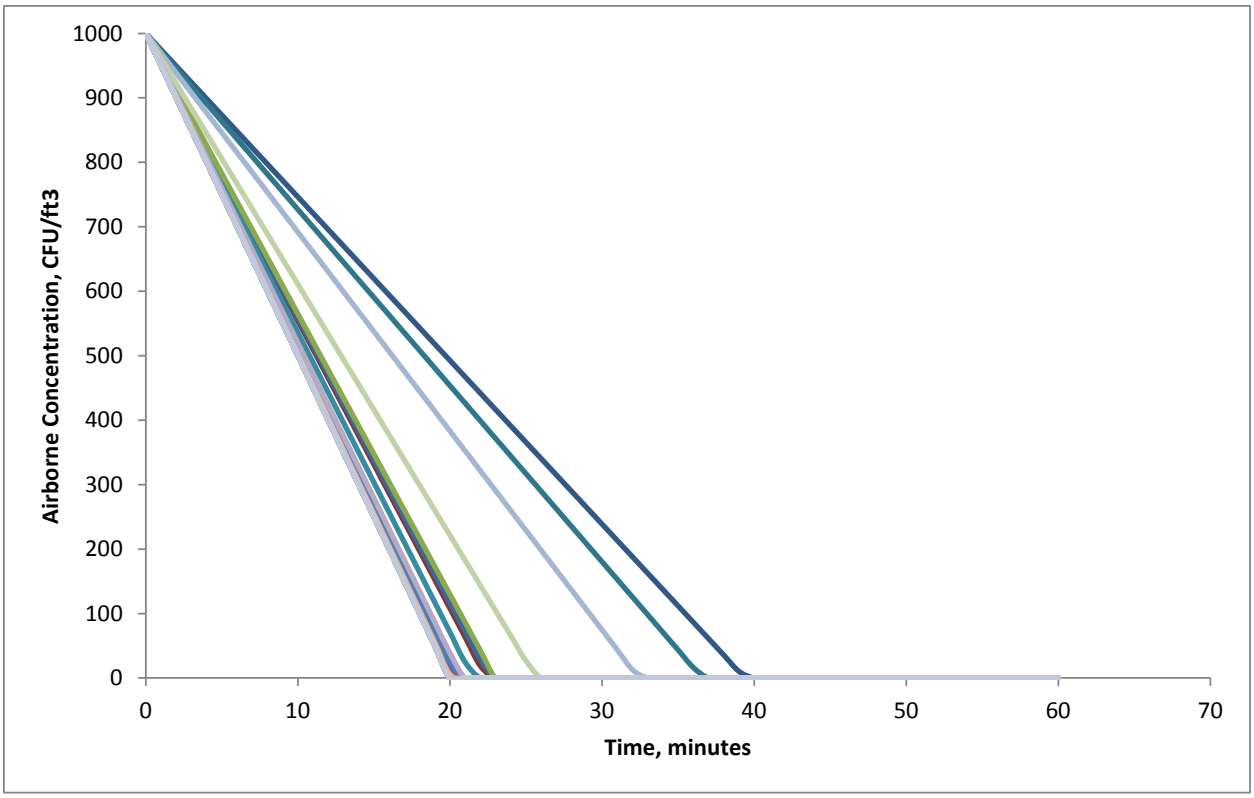


**Figure 5**: Removal of Bird pathogens by the UV24 unit in a room of 800 $ft^3$ volume with no outside air. Only microbes from Table 5A with known UV rate constants are included.

## Airborne Diseases of Rodents, Hamsters, and Rabbits

Table 6 lists all of the potentially airborne zoonotic pathogens of rodents, hamsters and rabbits. Table 6A summarizes the calculated removal rates for all the pathogens in Table 6, except where the UV rate constant is unknown. Figure 6 illustrates the removal rates of the pathogens in Table 6A in a model room of 800 $ft^3$ with no outside air and this graph only includes those pathogens with known UV rate constants. It can be observed in Figure 6 that all pathogens are removed to near-zero levels within about one hour.

## Table 6: Potentially Airborne Pathogens and Allergens of Rodents, Hamsters and Rabbits

| PATHOGEN or DISEASE | GROUP | DISEASE | Mean Dia. µm | UV k $m^2/J$ | UV D90 $J/m^2$ | Trans to Human |
|---|---|---|---|---|---|---|
| Actinomyces bovis | Bacteria | actinomycosis | 0.5 | - | - | No |
| Actinomyces israeli | Bacteria | actinomycosis | 0.5 | - | - | No |
| Aerococcus viridans | Bacteria | meningitis | 1 | - | - | No |
| Aeromonas spp. | Bacteria | bacteremia | 2.098 | 0.2031 | 11 | Yes |
| Bacillus anthracis | Bacterial Spore | Anthrax | 1.118 | 0.02702 | 85 | Yes |
| Bacteroides fragilis | Bacteria | opportunistic infection | 3.162 | 0.0675 | 34 | Yes |
| Bordetella bronchiseptica | Bacteria | kennel cough | 0.707 | 0.0364 | 63 | Yes |
| Burkholderia mallei | Bacteria | Glanders | 0.77 | 0.034 | 68 | Yes |
| Burkholderia pseudomallei | Bacteria | Meliodosis | 0.494 | 0.0344 | 67 | Yes |
| Chlamydophila muridarum | Bacteria | Chlamydiosis | 0.283 | - | - | No |
| Chlamydophila caviae (formerly C.psittaci) | Bacteria | Psittacosis, parrot fever | 0.283 | 0.039 | 59 | Yes |
| Clostridium tetani | Bacteria | tetanus | 5 | 0.04699 | 49 | Yes |
| Coccidioides immitis | Fungal Spore | Coccidioidomycosis | 3.464 | - | - | Yes |
| Coxiella burnettii | Bacteria | Q Fever | 0.283 | 0.1535 | 15 | Yes |
| Coxsackievirus | Virus | colds | 0.027 | 0.02834 | 81 | Yes |
| Echovirus | Virus | colds | 0.024 | 0.02786 | 83 | Yes |
| Francisella tularensis | Bacteria | tularemia, pneumonia, fever | 0.2 | 0.009 | 256 | Yes |
| Guineapig adenovirus | Virus | colds | 0.079 | 0.0026 | 886 | - |
| Hantavirus (Hantaan Virus) | Virus | Hemorrhagic Fever | 0.095 | 0.0688 | 33 | Yes |
| Haemophilus spp. | Bacteria | pneumonia, conjunctivitis | 0.285 | 0.0599 | 38 | Yes |
| Influenza A virus | Virus | flu, secondary pneumonia | 0.098 | 0.101 | 23 | Yes |
| Klebsiella pneumoniae | Bacteria | pneumonia | 0.671 | 0.04435 | 52 | Yes |
| Kyasanur Forest virus | Virus | viral disease | 0.045 | - | - | No |
| Leptospira spp. | Spirochete | Leptospirosis | 0.1 | NA | - | Yes |
| Listeria monocytogenes | Bacteria | Listeriosis | 0.707 | 0.0127 | 181 | Yes |
| Louping Ill (LIV) | Virus | Encephalomyelitis | 0.05 | 0.003289 | 700 | Yes |
| Lymphocytic choriomeningitis (LCMV) | Virus | Armstrong's disease | 0.087 | 0.0605 | 38 | Yes |
| Microsporum spp. | Fungal Spore | Dermatophyopsis | 2.96 | - | - | Yes |
| Mumps | Virus | mumps | 0.245 | 0.077 | 30 | Yes |
| Mycobacterium avium | Bacteria | Paratuberculosis, Johne's Disease | 1.118 | 0.04387 | 52 | Yes |
| Mycobacterium bovis | Bacteria | Tuberculosis | 0.637 | 0.181 | 13 | Yes |
| Mycoplasma spp. | Bacteria | infectious anemia, eye disease | 0.177 | 0.284 | 8 | Yes |
| Myxoma virus | Virus | Myxomatosis | 0.3 | unk | unk | No |
| Nipah virus (Henipah virus) | Virus | respiratory syndrome | 0.175 | 0.328941 | 7 | No |
| Omsk hemorrhagic fever | Virus | hemmorrhagic fever | 0.043 | - | - | No |
| Pasteurella multocida | Bacteria | Pasteurellosis, snuffles | 0.6 | unk | unk | Yes |
| Parainfluenza virus | Virus | flu, colds, croup, pneumonia | 0.194 | 0.1086 | 21 | Yes |
| Pseudomonas diminuta | Bacteria | rhinitis | 0.494 | 0.128 | 18 | Yes |
| Pseudorabies (PRV) | Virus | Aujeszky's Disease Virus (ADV) | 0.194 | 0.0676 | 34 | No |
| Rabies virus | Virus | rabies | 0.07 | 0.219 | 11 | Yes |
| Rabbit Haemorrhagic Disease | Virus | Rabbit Calicivirus (prev.) | 0.0307 | unk | unk | No |
| Reovirus | Virus | colds, fever, pneumonia | 0.08 | 0.016 | 144 | Yes |
| Salmonella enteritidis | Bacteria | Salmonellosis | 0.81 | 0.221 | 10 | Yes |
| Salmonella typhi | Bacteria | Salmonellosis | 0.81 | 0.1467 | 16 | Yes |
| Spirillus minus | Bacteria | Rat Bite Fever | 1 | - | - | No |
| Sporothrix schenckii | Fungal Spore | Sporotrichosis | 6.325 | - | - | Yes |
| Staphylococcus aureus (MRSA) | Bacteria | MRSA, various infections | 0.866 | 0.596 | 4 | Yes |
| Streptobacillus moniliformis | Bacteria | Rat Bite Fever | 0.707 | - | - | No |
| Streptococcus pneumoniae | Bacteria | pneumonia | 0.71 | 0.00492 | 468 | Yes |
| Streptococcus pyogenes | Bacteria | fever | 0.894 | 1.561 | 1 | Yes |
| Trichophyton spp. | Fungal Spore | Dermatophytosis | 7 | 0.00411 | 560 | Yes |
| Yersinia pestis | Bacteria | Bubonic & Pneumonic Plague | 0.707 | 0.106 | 22 | Yes |
| Yersinia pseudotuberculosis | Bacteria | pseudotuberculosis | 0.63 | 0.106 | 22 | Yes |

## Table 6A: UV24 Removal Rates for Rodent Pathogens

| PATHOGEN | Mean Dia. µm | MERV 6 Filtration, % | UV k $m^2/J$ | Single Pass UV Kill Rate, % | Total Removal Rate, % |
|---|---|---|---|---|---|
| Actinomyces bovis | 0.5 | 6.89 | - | - | - |
| Actinomyces israeli | 0.5 | 6.89 | - | - | - |
| Aerococcus viridans | 1 | 16.43 | - | - | - |
| Aeromonas spp. | 2.098 | 34.77 | 0.2 | 100.00 | 100.00 |
| Bacillus anthracis | 1.118 | 18.79 | 0.03 | 99.53 | 99.61 |
| Bacteroides fragilis | 3.162 | 43.79 | 0.07 | 100.00 | 100.00 |
| Bordetella bronchiseptica | 0.707 | 10.57 | 0.04 | 99.93 | 99.93 |
| Burkholderia mallei | 0.77 | 11.80 | 0.03 | 99.88 | 99.89 |
| Burkholderia pseudomallei | 0.494 | 6.80 | 0.03 | 99.89 | 99.90 |
| Chlamydophila muridarum | 0.283 | 4.42 | - | - | - |
| Chlamydophila caviae (formerly C.psittaci) | 0.283 | 4.42 | 0.04 | 99.96 | 99.96 |
| Clostridium tetani | 5 | 48.83 | 0.05 | 99.99 | 100.00 |
| Coccidioides immitis | 3.464 | 45.25 | - | - | - |
| Coxiella burnettii | 0.283 | 4.42 | 0.15 | 100.00 | 100.00 |
| Coxsackievirus | 0.027 | 18.86 | 0.03 | 99.63 | 99.70 |
| Echovirus | 0.024 | 20.12 | 0.03 | 99.60 | 99.68 |
| Francisella tularensis | 0.2 | 4.43 | 0.01 | 83.17 | 83.91 |
| Guineapig adenovirus | 0.079 | 8.53 | 0 | 40.24 | 45.34 |
| Hantavirus (Hantaan Virus) | 0.095 | 7.28 | 0.07 | 100.00 | 100.00 |
| Haemophilus spp. | 0.285 | 4.43 | 0.06 | 100.00 | 100.00 |
| Influenza A virus | 0.098 | 7.09 | 0.1 | 100.00 | 100.00 |
| Klebsiella pneumoniae | 0.671 | 9.88 | 0.04 | 99.98 | 99.99 |
| Kyasanur Forest virus | 0.045 | 13.48 | - | - | - |
| Leptospira spp. | 0.1 | 6.97 | - | - | - |
| Listeria monocytogenes | 0.707 | 10.57 | 0.01 | 91.91 | 92.77 |
| Louping Ill (LIV) | 0.05 | 12.45 | 0 | 47.86 | 54.35 |
| Lymphocytic choriomeningitis (LCMV) | 0.087 | 7.85 | 0.06 | 100.00 | 100.00 |
| Microsporum spp. | 2.96 | 42.60 | - | - | - |
| Mumps | 0.245 | 4.31 | 0.08 | 100.00 | 100.00 |
| Mycobacterium avium | 1.118 | 18.79 | 0.04 | 99.98 | 99.99 |
| Mycobacterium bovis | 0.637 | 9.25 | 0.18 | 100.00 | 100.00 |
| Mycoplasma spp. | 0.177 | 4.64 | 0.28 | 100.00 | 100.00 |
| Myxoma virus | 0.3 | 4.52 | unk | - | - |
| Nipah virus (Henipah virus) | 0.175 | 4.67 | 0.33 | 100.00 | 100.00 |
| Omsk hemorrhagic fever | 0.043 | 13.94 | - | - | - |
| Pasteurella multocida | 0.6 | 8.58 | unk | - | - |
| Parainfluenza virus | 0.194 | 4.47 | 0.11 | 100.00 | 100.00 |
| Pseudomonas diminuta | 0.494 | 6.80 | 0.13 | 100.00 | 100.00 |
| Pseudorabies (PRV) | 0.194 | 4.47 | 0.07 | 100.00 | 100.00 |
| Rabies virus | 0.07 | 9.46 | 0.22 | 100.00 | 100.00 |
| Rabbit Haemorrhagic Disease | 0.0307 | 17.48 | unk | - | - |
| Reovirus | 0.08 | 8.44 | 0.02 | 95.79 | 96.15 |
| Salmonella enteritidis | 0.81 | 12.59 | 0.22 | 100.00 | 100.00 |
| Salmonella typhi | 0.81 | 12.59 | 0.15 | 100.00 | 100.00 |
| Spirillus minus | 1 | 16.43 | - | - | - |
| Sporothrix schenckii | 6.325 | 49.66 | - | - | - |
| Staphylococcus aureus (MRSA) | 0.866 | 13.72 | 0.6 | 100.00 | 100.00 |
| Streptobacillus moniliformis | 0.707 | 10.57 | - | - | - |
| Streptococcus pneumoniae | 0.71 | 10.63 | 0 | 62.25 | 66.26 |
| Streptococcus pyogenes | 0.894 | 14.28 | 1.56 | 100.00 | 100.00 |
| Trichophyton spp. | 7 | 49.82 | 0 | 55.68 | 77.76 |
| Yersinia pestis | 0.707 | 10.57 | 0.11 | 100.00 | 100.00 |
| Yersinia pseudotuberculosis | 0.63 | 9.12 | 0.11 | 100.00 | 100.00 |

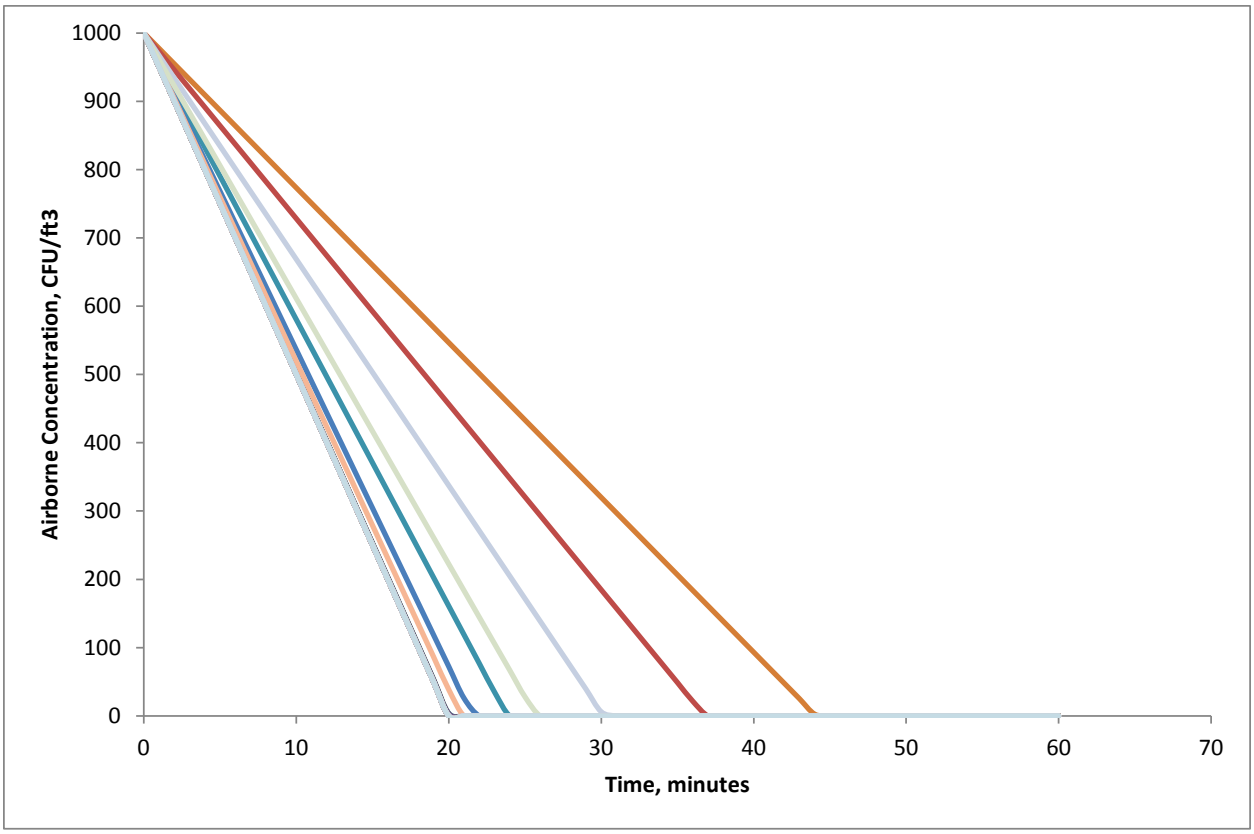


**Figure 6**: Removal of Rodent pathogens by the UV24 unit in a room of 800 $ft^3$ volume with no outside air. Only microbes from Table 6A with known UV rate constants are included.

# Airborne Diseases of Horses

Table 7 lists all of the potentially airborne zoonotic pathogens of horses. Table 7A summarizes the calculated removal rates for all the pathogens in Table 6, except where the UV rate constant is unknown. Figure 7 illustrates the removal rates of the pathogens in Table 7A in a model room of 800 $ft^3$ with no outside air and this graph only includes those pathogens with known UV rate constants. It can be observed in Figure 7 that all pathogens are removed to near-zero levels within about one hour.

**Table 7: Potentially Airborne Pathogens and Allergens of Horses**

| PATHOGEN or DISEASE | GROUP | DISEASE | Mean Dia. µm | UV k $m^2/J$ | UV D90 $J/m^2$ | Trans to Human |
|---|---|---|---|---|---|---|
| Arterivirus | Virus | EAV, PRRD | 0.05 | - | - | No |
| Avian Influenza A | Virus | Flu | 0.098 | 0.101 | 23 | Yes |
| Bacillus anthracis | Bacterial Spore | Anthrax | 1.118 | 0.02702 | 85 | Yes |
| Brucella abortus | Bacteria | Brucellosis, undulant fever | 0.57 | 0.0307 | 75 | Yes |
| Brucella canis | Bacteria | Brucellosis, undulant fever | 0.566 | 0.048 | 48 | Yes |
| Brucella maris | Bacteria | Brucellosis | 0.566 | 0.047 | 49 | No |
| Brucella melitensis | Bacteria | Brucellosis | 0.566 | 0.047 | 49 | Yes |
| Brucella neotomae | Bacteria | Brucellosis | 0.566 | 0.047 | 49 | No |
| Brucella ovis | Bacteria | Brucellosis | 0.566 | 0.047 | 49 | No |
| Brucella suis | Bacteria | Brucellosis | 0.57 | 0.047 | 49 | Yes |
| Burkholderia mallei | Bacteria | Glanders | 0.77 | 0.034 | 68 | Yes |
| Burkholderia pseudomallei | Bacteria | Meliodosis | 0.494 | 0.0344 | 67 | Yes |
| Canine Influenza H3N8 | Virus | Flu | 0.098 | 0.101 | 23 | No |
| Clostridium botulinum | Bacteria | Botulism | 1.975 | 0.0412 | 56 | Yes |
| Clostridium difficile | Bacteria | diarrhea | 0.6 | 0.0385 | 60 | Yes |
| Clostridium perfringens | Bacteria | sepsis, toxins, food poisoning | 5 | 0.06 | 38 | Yes |
| Clostridium tetani | Bacteria | tetanus | 5 | 0.04699 | 49 | Yes |
| Coccidioides immitis | Fungal Spore | Coccidioidomycosis | 3.464 | - | - | Yes |
| Coxiella burnettii | Bacteria | Q Fever | 0.283 | 0.1535 | 15 | Yes |
| Cryptococcus farciminosis | Fungi | Cryptococcosis | 4.9 | 0.0167 | 138 | Yes |
| Cryptococcus neoformans | Fungi | Cryptococcosis | 4.899 | 0.0167 | 138 | Yes |
| Dermatophilus congolensis | Bacteria | dermatophilosis, mud fever | 1 | - | - | No |
| Enterobacter | Bacteria | Bacteremia | 1.414 | 0.036 | 64 | Yes |
| Epidermophyton | Fungi | Dermatophytosis | 8.5 | - | - | Yes |
| Equine Influenza | Virus | Flu | 0.1 | 0.101 | 23 | No |
| Feline Influenza A (H7N2) | Virus | Flu | 0.10 | 0.101 | 23 | Yes |
| Hendra Virus | Virus | Pneumonia | 0.175 | 0.230259 | 10 | Yes |
| Histoplasma farciminosum | Fungal Spore | URD | 2.236 | 0.01645 | 140 | No |
| Louping Ill (LIV) | Virus | Encephalomyelitis | 0.05 | 0.003289 | 700 | Yes |
| Microsporum spp. | Fungal Spore | Dermatophyopsis | 2.96 | - | - | Yes |
| Mycobacterium avium | Bacteria | Paratuberculosis, Johne's Disease | 1.118 | 0.04387 | 52 | Yes |
| Nipah virus (Henipah virus) | Virus | respiratory syndrome | 0.175 | 0.328941 | 7 | No |
| Salmonella enteritidis | Bacteria | Salmonellosis | 0.81 | 0.221 | 10 | Yes |
| Salmonella typhi | Bacteria | Salmonellosis | 0.81 | 0.1467 | 16 | Yes |
| Sporothrix schenckii | Fungal Spore | Sporotrichosis | 6.325 | - | - | Yes |
| Staphylococcus aureus (MRSA) | Bacteria | MRSA, various infections | 0.866 | 0.596 | 4 | Yes |
| Streptococcus pyogenes | Bacteria | fever | 0.894 | 1.561 | 1 | Yes |
| Trichophyton spp. | Fungal Spore | Dermatophytosis | 7 | 0.00411 | 560 | Yes |

## Table 7A: UV24 Removal Rates for Horse Pathogens

| PATHOGEN | Mean Dia. μm | MERV 6 Filtration, % | UV k $m^2/J$ | Single Pass UV Kill Rate, % | Total Removal Rate, % |
|---|---|---|---|---|---|
| Arterivirus | 0.05 | 12.45 | - | - | - |
| Avian Influenza A | 0.098 | 7.09 | 0.1010 | 100.00 | 100.00 |
| Bacillus anthracis | 1.118 | 18.79 | 0.0270 | 99.53 | 99.61 |
| Brucella abortus | 0.57 | 8.05 | 0.0307 | 99.77 | 99.79 |
| Brucella canis | 0.566 | 7.98 | 0.0480 | 99.99 | 99.99 |
| Brucella maris | 0.566 | 7.98 | 0.0470 | 99.99 | 99.99 |
| Brucella melitensis | 0.566 | 7.98 | 0.0470 | 99.99 | 99.99 |
| Brucella neotomae | 0.566 | 7.98 | 0.0470 | 99.99 | 99.99 |
| Brucella ovis | 0.566 | 7.98 | 0.0470 | 99.99 | 99.99 |
| Brucella suis | 0.57 | 8.05 | 0.0470 | 99.99 | 99.99 |
| Burkholderia mallei | 0.77 | 11.80 | 0.0340 | 99.88 | 99.89 |
| Burkholderia pseudomallei | 0.494 | 6.80 | 0.0344 | 99.89 | 99.90 |
| Canine Influenza H3N8 | 0.098 | 7.09 | 0.1010 | 100.00 | 100.00 |
| Clostridium botulinum | 1.975 | 33.20 | 0.0412 | 99.97 | 99.98 |
| Clostridium difficile | 0.6 | 8.58 | 0.0385 | 99.95 | 99.96 |
| Clostridium perfringens | 5 | 48.83 | 0.0600 | 100.00 | 100.00 |
| Clostridium tetani | 5 | 48.83 | 0.0470 | 99.99 | 100.00 |
| Coccidioides immitis | 3.464 | 45.25 | - | - | - |
| Coxiella burnettii | 0.283 | 4.42 | 0.1535 | 100.00 | 100.00 |
| Cryptococcus farciminosis | 4.9 | 48.72 | 0.0167 | 96.34 | 98.12 |
| Cryptococcus neoformans | 4.899 | 48.72 | 0.0167 | 96.34 | 98.12 |
| Dermatophilus congolensis | 1 | 16.43 | - | - | - |
| Enterobacter | 1.414 | 24.42 | 0.0360 | 99.92 | 99.94 |
| Epidermophyton | 8.5 | 49.96 | - | - | - |
| Equine Influenza | 0.1 | 6.97 | 0.1010 | 100.00 | 100.00 |
| Feline Influenza A (H7N2) | 0.098 | 7.09 | 0.1010 | 100.00 | 100.00 |
| Hendra Virus | 0.175 | 4.67 | 0.2303 | 100.00 | 100.00 |
| Histoplasma farciminosum | 2.236 | 36.37 | 0.0165 | 96.15 | 97.55 |
| Louping Ill (LIV) | 0.05 | 12.45 | 0.0033 | 47.86 | 54.35 |
| Microsporum spp. | 2.96 | 42.60 | - | - | - |
| Mycobacterium avium | 1.118 | 18.79 | 0.0439 | 99.98 | 99.99 |
| Nipah virus (Henipah virus) | 0.175 | 4.67 | 0.3289 | 100.00 | 100.00 |
| Salmonella enteritidis | 0.81 | 12.59 | 0.2210 | 100.00 | 100.00 |
| Salmonella typhi | 0.81 | 12.59 | 0.1467 | 100.00 | 100.00 |
| Sporothrix schenckii | 6.325 | 49.66 | - | - | - |
| Staphylococcus aureus (MRSA) | 0.866 | 13.72 | 0.5960 | 100.00 | 100.00 |
| Streptococcus pyogenes | 0.894 | 14.28 | 1.5610 | 100.00 | 100.00 |
| Trichophyton spp. | 7 | 49.82 | 0.0041 | 55.68 | 77.76 |

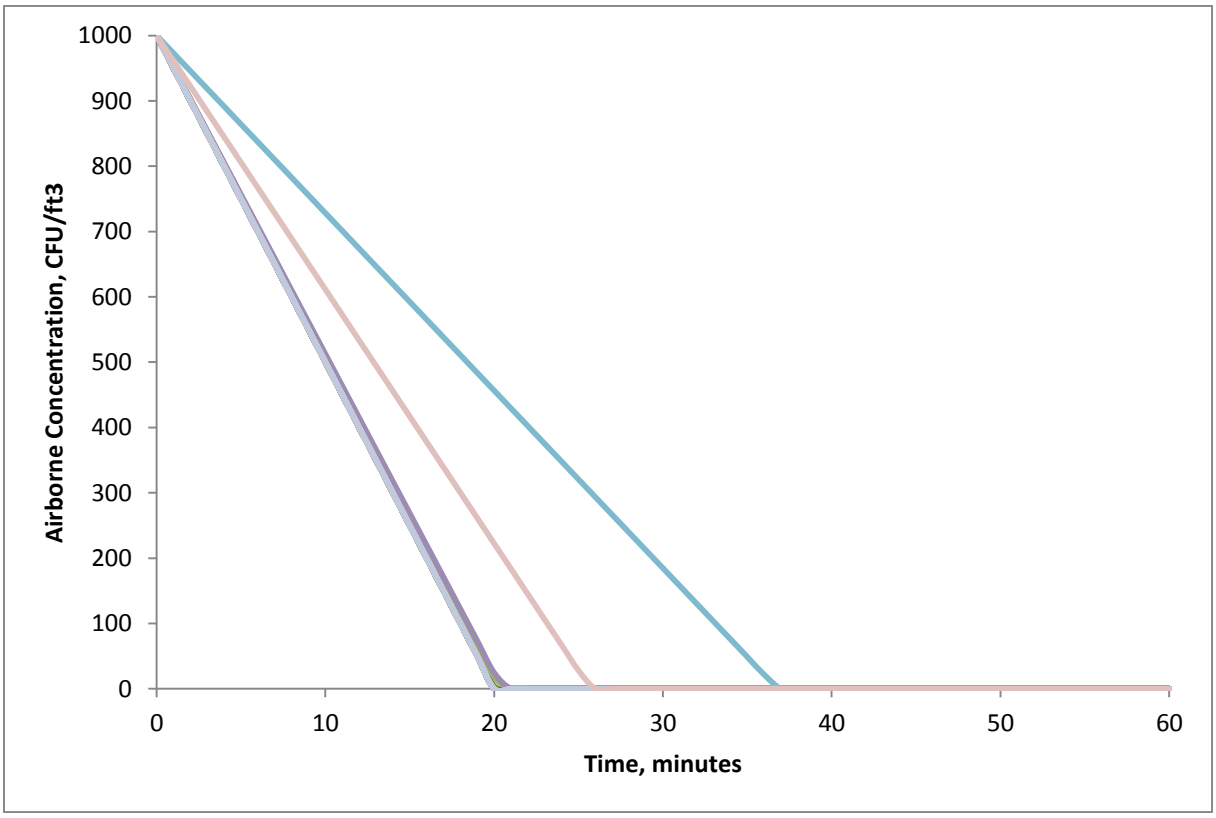


**Figure 7**: Removal of Horse pathogens by the UV24 unit in a room of 800 $ft^3$ volume with no outside air. Only microbes from Table 7A with known UV rate constants are included.

## Airborne Diseases of Cows

Table 8 lists all of the potentially airborne zoonotic pathogens of cows. Table 8A summarizes the calculated removal rates for all the pathogens in Table 8, except where the UV rate constant is unknown. Figure 8 illustrates the removal rates of the pathogens in Table 8A in a model room of 800 $ft^3$ with no outside air and this graph only includes those pathogens with known UV rate constants. It can be observed in Figure 8 that all pathogens are removed to near-zero levels within about one hour.

**Table 8: Potentially Airborne Pathogens and Allergens of Cows**

| PATHOGEN or DISEASE | GROUP | DISEASE | Mean dia. µm | UV k $m^2/J$ | UV D90 $J/m^2$ | Trans to Human |
|---|---|---|---|---|---|---|
| Actinomyces bovis | Bacteria | actinomycosis | 0.5 | - | - | No |
| Bacillus anthracis | Bacterial Spore | Anthrax | 1.118 | 0.02702 | 85 | Yes |
| Bovine Coronavirus (BCV) | Virus | respiratory infections | 0.113 | 0.377 | 6 | No |
| Brucella abortus | Bacteria | Brucellosis, undulant fever | 0.57 | 0.0307 | 75 | Yes |
| Brucella canis | Bacteria | Brucellosis, undulant fever | 0.566 | 0.048 | 48 | Yes |
| Brucella maris | Bacteria | Brucellosis | 0.566 | 0.047 | 49 | No |
| Brucella melitensis | Bacteria | Brucellosis | 0.566 | 0.047 | 49 | Yes |
| Brucella neotomae | Bacteria | Brucellosis | 0.566 | 0.047 | 49 | No |
| Brucella ovis | Bacteria | Brucellosis | 0.566 | 0.047 | 49 | No |
| Brucella suis | Bacteria | Brucellosis | 0.57 | 0.047 | 49 | Yes |
| Burkholderia pseudomallei | Bacteria | Meliodosis | 0.494 | 0.0344 | 67 | Yes |
| Campylobacter coli | Bacteria | Enteritis, Campylobacteriosis | 2.12 | 0.144 | 16 | Yes |
| Campylobacter jejuni | Bacteria | Enteritis | 2.12 | 0.1444 | 16 | Yes |
| Chlamydophila abortus | Bacteria | Chlamydiosis | 0.283 | - | 0 | No |
| Chlamydophila felis | Bacteria | Chlamydiosis | 0.283 | 0.0384 | 60 | No |
| Chlamydophila pneumoniae | Bacteria | Chlamydiosis | 0.283 | 0.039 | 59 | Yes |
| Clostridium botulinum | Bacteria | Botulism | 1.975 | 0.0412 | 56 | Yes |
| Clostridium perfringens | Bacteria | sepsis, toxins, food poisoning | 5 | 0.06 | 38 | Yes |
| Coccidioides immitis | Fungal Spore | Coccidioidomycosis | 3.464 | - | - | Yes |
| Coxiella burnettii | Bacteria | Q Fever | 0.283 | 0.1535 | 15 | Yes |
| Cryptococcus neoformans | Fungi | Cryptococcosis | 4.899 | 0.0167 | 138 | Yes |
| Dermatophilus congolensis | Bacteria | dermatophilosis, mud fever | 1 | - | - | No |
| Epidermophyton | Fungi | Dermatophytosis | 8.5 | - | - | Yes |
| Leptospira spp. | Spirochete | Leptospirosis | 0.1 | NA | - | Yes |
| Listeria monocytogenes | Bacteria | Listeriosis | 0.707 | 0.0127 | 181 | Yes |
| Louping Ill (LIV) | Virus | Encephalomyelitis | 0.05 | 0.003289 | 700 | Yes |
| Microsporum spp. | Fungal Spore | Dermatophyopsis | 2.96 | - | - | Yes |
| Mycobacterium avium | Bacteria | Paratuberculosis, Johne's Disease | 1.118 | 0.04387 | 52 | Yes |
| Mycobacterium bovis | Bacteria | Tuberculosis | 0.637 | 0.181 | 13 | Yes |
| Pseudorabies (PRV) | Virus | Aujeszky's Disease Virus (ADV) | 0.194 | 0.0676 | 34 | No |
| Rabies virus | Virus | rabies | 0.07 | 0.219 | 11 | Yes |
| Salmonella enteritidis | Bacteria | Salmonellosis | 0.81 | 0.221 | 10 | Yes |
| Salmonella typhi | Bacteria | Salmonellosis | 0.81 | 0.1467 | 16 | Yes |
| Staphylococcus aureus (MRSA) | Bacteria | MRSA, various infections | 0.866 | 0.596 | 4 | Yes |
| Streptococcus pyogenes | Bacteria | fever | 0.894 | 1.561 | 1 | Yes |
| Trichophyton spp. | Fungal Spore | Dermatophytosis | 7 | 0.00411 | 560 | Yes |

## Table 8A: UV24 Removal Rates for Cow Pathogens

| PATHOGEN | Mean Dia. μm | MERV 6 Filtration, % | UV k $m^2/J$ | Single Pass UV Kill Rate, % | Total Removal Rate, % |
|---|---|---|---|---|---|
| Actinomyces bovis | 0.5 | 6.89 | - | - | - |
| Bacillus anthracis | 1.118 | 18.79 | 0.0270 | 99.53 | 99.61 |
| Bovine Coronavirus (BCV) | 0.113 | 6.29 | 0.3770 | 100.00 | 100.00 |
| Brucella abortus | 0.57 | 8.05 | 0.0307 | 99.77 | 99.79 |
| Brucella canis | 0.566 | 7.98 | 0.0480 | 99.99 | 99.99 |
| Brucella maris | 0.566 | 7.98 | 0.0470 | 99.99 | 99.99 |
| Brucella melitensis | 0.566 | 7.98 | 0.0470 | 99.99 | 99.99 |
| Brucella neotomae | 0.566 | 7.98 | 0.0470 | 99.99 | 99.99 |
| Brucella ovis | 0.566 | 7.98 | 0.0470 | 99.99 | 99.99 |
| Brucella suis | 0.57 | 8.05 | 0.0470 | 99.99 | 99.99 |
| Burkholderia pseudomallei | 0.494 | 6.80 | 0.0344 | 99.89 | 99.90 |
| Campylobacter coli | 2.12 | 35.03 | 0.1440 | 100.00 | 100.00 |
| Campylobacter jejuni | 2.12 | 35.03 | 0.1444 | 100.00 | 100.00 |
| Chlamydophila abortus | 0.283 | 4.42 | - | - | - |
| Chlamydophila felis | 0.283 | 4.42 | 0.0384 | 99.95 | 99.95 |
| Chlamydophila pneumoniae | 0.283 | 4.42 | 0.0390 | 99.96 | 99.96 |
| Clostridium botulinum | 1.975 | 33.20 | 0.0412 | 99.97 | 99.98 |
| Clostridium perfringens | 5 | 48.83 | 0.0600 | 100.00 | 100.00 |
| Coccidioides immitis | 3.464 | 45.25 | - | - | - |
| Coxiella burnettii | 0.283 | 4.42 | 0.1535 | 100.00 | 100.00 |
| Cryptococcus neoformans | 4.899 | 48.72 | 0.0167 | 96.34 | 98.12 |
| Dermatophilus congolensis | 1 | 16.43 | - | - | - |
| Epidermophyton | 8.5 | 49.96 | - | - | - |
| Leptospira spp. | 0.1 | 6.97 | - | - | - |
| Listeria monocytogenes | 0.707 | 10.57 | 0.0127 | 91.91 | 92.77 |
| Louping Ill (LIV) | 0.05 | 12.45 | 0.0033 | 47.86 | 54.35 |
| Microsporum spp. | 2.96 | 42.60 | - | - | - |
| Mycobacterium avium | 1.118 | 18.79 | 0.0439 | 99.98 | 99.99 |
| Mycobacterium bovis | 0.637 | 9.25 | 0.1810 | 100.00 | 100.00 |
| Pseudorabies (PRV) | 0.194 | 4.47 | 0.0676 | 100.00 | 100.00 |
| Rabies virus | 0.07 | 9.46 | 0.2190 | 100.00 | 100.00 |
| Salmonella enteritidis | 0.81 | 12.59 | 0.2210 | 100.00 | 100.00 |
| Salmonella typhi | 0.81 | 12.59 | 0.1467 | 100.00 | 100.00 |
| Staphylococcus aureus (MRSA) | 0.866 | 13.72 | 0.5960 | 100.00 | 100.00 |
| Streptococcus pyogenes | 0.894 | 14.28 | 1.5610 | 100.00 | 100.00 |
| Trichophyton spp. | 7 | 49.82 | 0.0041 | 55.68 | 77.76 |

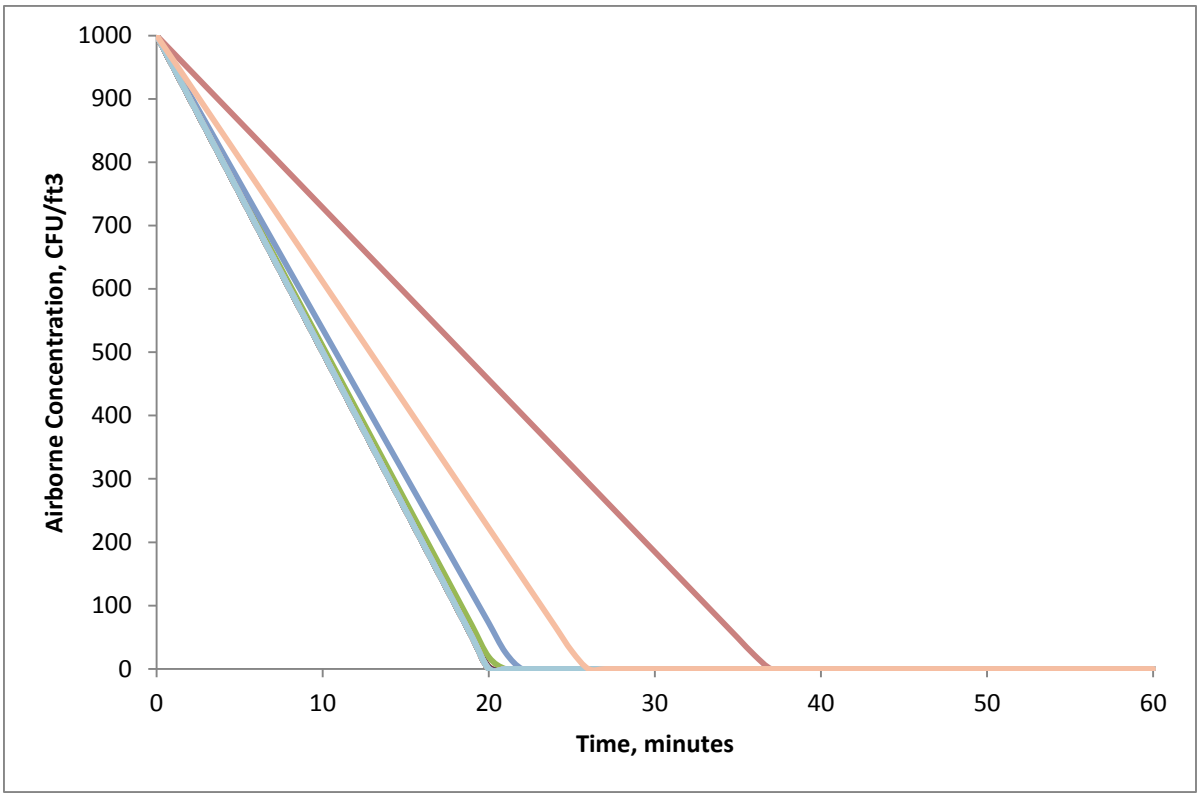


**Figure 8**: Removal of Bovine pathogens by the UV24 unit in a room of 800 $ft^3$ volume with no outside air. Only microbes from Table 8A with known UV rate constants are included.

## Airborne Diseases of Swine

Table 9 lists all of the potentially airborne zoonotic pathogens of swine. Table 9A summarizes the calculated removal rates for all the pathogens in Table 9, except where the UV rate constant is unknown. Figure 9 illustrates the removal rates of the pathogens in Table 9A in a model room of 800 $ft^3$ with no outside air and this graph only includes those pathogens with known UV rate constants. It can be observed in Figure 9 that all pathogens are removed to near-zero levels within about one hour.

**Table 9: Potentially Airborne Pathogens and Allergens of Swine**

| PATHOGEN or DISEASE | GROUP | DISEASE | Mean Dia. μm | UV k $m^2/J$ | UV D90 $J/m^2$ | Trans to Human |
|---|---|---|---|---|---|---|
| Arterivirus | V | EAV, PRRD | 0.05 | - | - | No |
| Bovine Coronavirus (BCV) | V | respiratory infections | 0.113 | 0.377 | 6 | No |
| Brucella abortus | B | Brucellosis, undulant fever | 0.57 | 0.0307 | 75 | Yes |
| Brucella melitensis | B | Brucellosis | 0.566 | 0.047 | 49 | Yes |
| Clostridium perfringens | B | sepsis, toxins, food poisoning | 5 | 0.06 | 38 | Yes |
| Mycobacterium avium | B | Paratuberculosis, Johne's Disease | 1.118 | 0.04387 | 52 | Yes |
| Mycoplasma hyopneumoniae | B | chronic infectious pneumoniae | 0.177 | 0.284 | 8 | No |
| Porcine Respiratory Coronavirus (PRCV) | V | respiratory disease | 0.14 | 0.1706 | 13 | No |
| Pseudorabies (PRV) | V | Aujeszky's Disease Virus (ADV) | 0.194 | 0.0676 | 34 | No |
| Salmonella enteritidis | B | Salmonellosis | 0.81 | 0.221 | 10 | Yes |
| Salmonella typhi | B | Salmonellosis | 0.81 | 0.1467 | 16 | Yes |
| Swine Influenza | V | H1N1 flu | 0.1 | 0.098 | 23 | Yes |

**Table 9A: UV24 Removal Rates for Swine Pathogens**

| PATHOGEN | Mean Dia. μm | MERV 6 Filtration, % | UV k $m^2/J$ | Single Pass UV Kill Rate, % | Total Removal Rate, % |
|---|---|---|---|---|---|
| Arterivirus | 0.05 | 12.45 | - | - | - |
| Bovine Coronavirus (BCV) | 0.113 | 6.29 | 0.3770 | 100.00 | 100.00 |
| Brucella abortus | 0.57 | 8.05 | 0.0307 | 99.77 | 99.79 |
| Brucella melitensis | 0.566 | 7.98 | 0.0470 | 99.99 | 99.99 |
| Clostridium perfringens | 5 | 48.83 | 0.0600 | 100.00 | 100.00 |
| Mycobacterium avium | 1.118 | 18.79 | 0.0439 | 99.98 | 99.99 |
| Mycoplasma hyopneumoniae | 0.177 | 4.64 | 0.2840 | 100.00 | 100.00 |
| Porcine Respiratory Coronavirus (PRCV) | 0.14 | 5.34 | 0.1706 | 100.00 | 100.00 |
| Pseudorabies (PRV) | 0.194 | 4.47 | 0.0676 | 100.00 | 100.00 |
| Salmonella enteritidis | 0.81 | 12.59 | 0.2210 | 100.00 | 100.00 |
| Salmonella typhi | 0.81 | 12.59 | 0.1467 | 100.00 | 100.00 |
| Swine Influenza | 0.1 | 6.97 | 0.0980 | 100.00 | 100.00 |

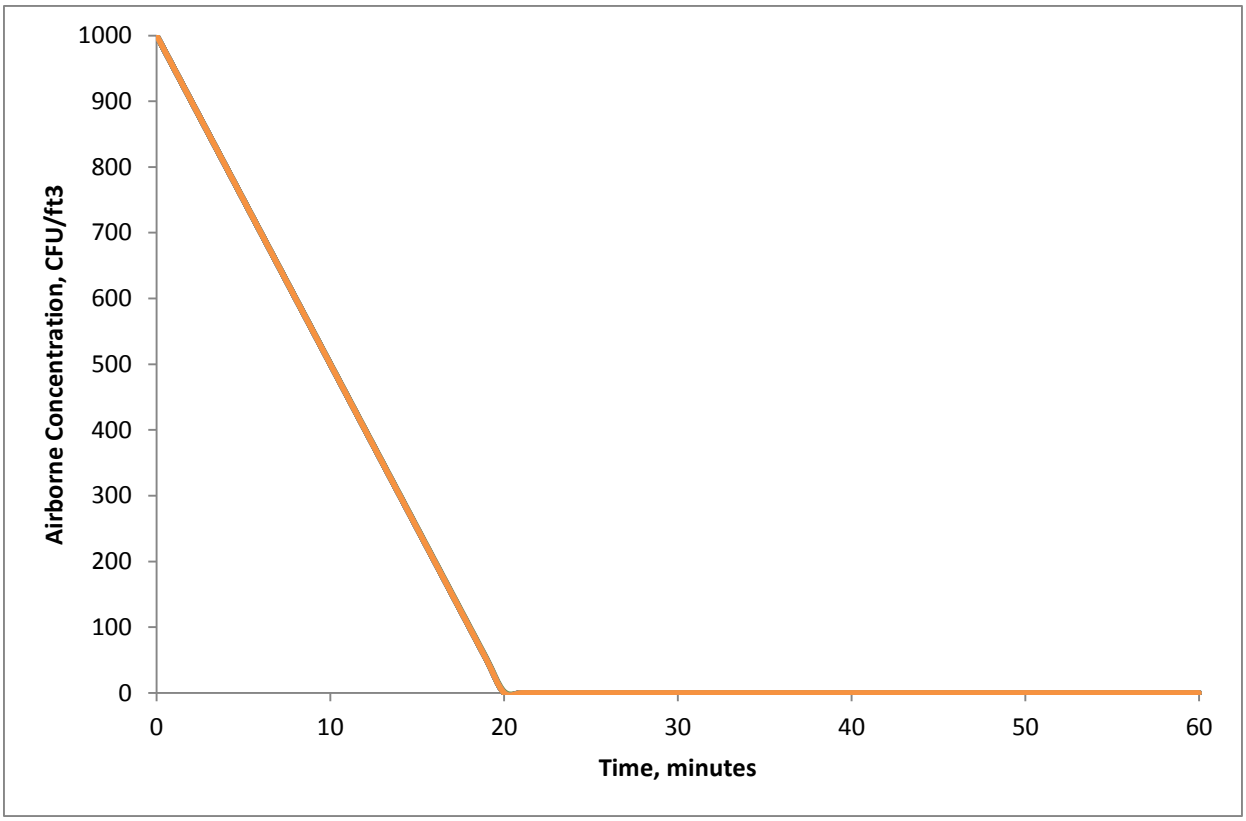


**Figure 9**: Removal of Swine pathogens by the UV24 unit in a room of 800 $ft^3$ volume with no outside air. Only microbes from Table 9A with known UV rate constants are included.

## Airborne Diseases of Reptiles and Amphibians

Table 10 lists all of the potentially airborne zoonotic pathogens of reptiles and amphibians. Table 10A summarizes the calculated removal rates for all the pathogens in Table 10, except where the UV rate constant is unknown. Figure 10 illustrates the removal rates of the pathogens in Table 10A in a model room of 800 $ft^3$ with no outside air and this graph only includes those pathogens with known UV rate constants. It can be observed in Figure 10 that all pathogens are removed to near-zero levels within about one hour.

**Table 10: Potentially Airborne Pathogens and Allergens of Reptiles and Amphibians**

| PATHOGEN or DISEASE | GROUP | DISEASE | Mean Dia. μm | UV k $m^2/J$ | UV D90 $J/m^2$ | Trans to Human |
|---|---|---|---|---|---|---|
| Adenovirus | Virus | hepatitis | 0.093 | 0.026 | 89 | No |
| Batrachochytrium dendrobatidis | Fungi | Chytridiomycosis | 4 | unk | unk | No |
| Calicivirus | Virus | fever, conjunctivitis | 0.034 | 0.0345 | 66.7416 | No |
| Herpesvirus | Virus | Pneumonia, respiratory infection | 0.18 | 0.0568 | 41 | No |
| Mycobacteria | Bacteria | Mycobacteriosis | 0.1 | unk | unk | Yes |
| Mycoplasma agassizii | Bacteria | upper respiratory tract disease | 0.177 | 0.284 | 8 | No |
| Ophidian Paramyxovirus (PMV) | Virus | Pneumonia, respiratory infection | 0.15 | unk | unk | No |
| Reovirus | Virus | Pneumonia, respiratory infection | 0.08 | 0.016 | 143.9116 | Yes |

**Table 10A: UV24 Removal Rates for Reptile Pathogens**

| PATHOGEN | Mean Dia. μm | MERV 6 Filtration, % | UV k $m^2/J$ | Single Pass UV Kill Rate, % | Total Removal Rate, % |
|---|---|---|---|---|---|
| Adenovirus | 0.093 | 7.41 | 0.0260 | - | - |
| Batrachochytrium dendrobatidis | 4 | 47.06 | unk | - | - |
| Calicivirus | 0.034 | 16.39 | 0.0345 | 99.89 | 99.91 |
| Herpesvirus | 0.18 | 4.60 | 0.0568 | 100.00 | 100.00 |
| Mycobacteria | 0.1 | 6.97 | unk | - | - |
| Mycoplasma agassizii | 0.177 | 4.64 | 0.2840 | 100.00 | 100.00 |
| Ophidian Paramyxovirus (PMV) | 0.15 | 5.09 | unk | - | - |
| Reovirus | 0.08 | 8.44 | 0.0160 | 95.79 | 96.15 |

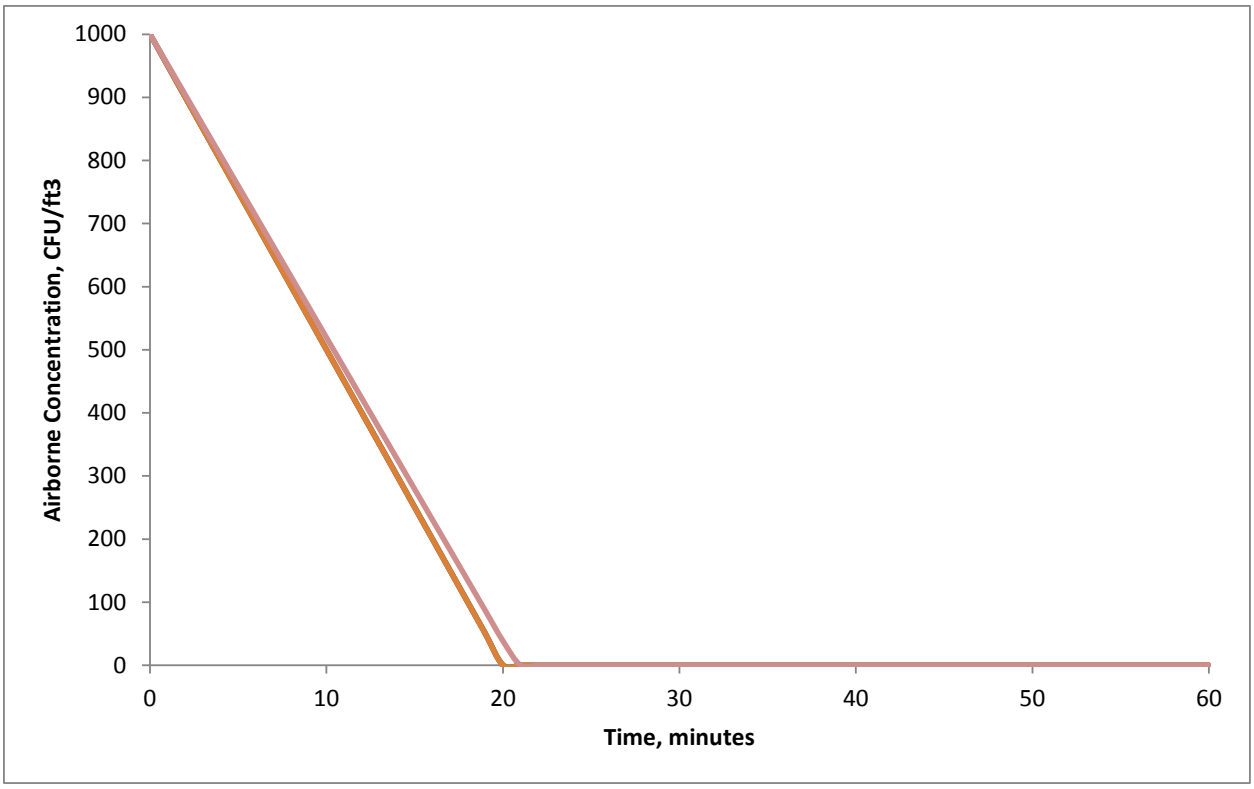


**Figure 10**: Removal of Reptile and Amphibian pathogens by the UV24 unit in a room of 800 $ft^3$ volume with no outside air. Only microbes from Table 10A with known UV rate constants are included.

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# Appendix A: Nonairborne Zoonotic Pathogens

## Appendix A: Nonairborne Zoonotic Pathogens and Allergens

| PATHOGEN | Group | Host | DISEASE |
|---|---|---|---|
| African Animal Trypanosomiasis (AAT) | Protozoa | DCR | Nagana, Tsetse Disease |
| African Horse Sickness Virus (AHS) | Virus | DE | African Horse Sickness |
| African Swine Fever virus | Virus | S | ASF |
| Ainovirus (Bunyaviridae Orthobunyavirus) | Virus | O | Aino Virus Infection, Akabane |
| Air Sac Mite | Insect | B | lung and airway disorder |
| Anaplasma phagocytophilium (Ehrlichia equi) | Bacteria | DCREO | Ehrlichosis, anaplasmosis |
| Ancylostoma spp. | Nematode | DC | Larva Migrans |
| Avian Enteric Reovirus | Virus | P | Malabsorption syndrome |
| Avian Pathogenic E. coli (APEC) | Bacteria | P | intestinal diseases |
| Avian Reovirus | Virus | P | viral arthritis |
| Avibacterium paragallinarum | Bacteria | P | coryza |
| Babesia gibsoni | Protozoa | DC | hemolytic anemia |
| Bartonella bovis | Bacteria | E | endocarditis |
| Bartonella clarridgeiae | Bacteria | C | Cat Scratch Fever |
| Bartonella henselae | Bacteria | C | Cat Scratch Fever |
| Baylisascaris procyonis | Helminth | D | Verminous myelitis |
| Besnoitia besnoiti | Protozoa | O | Bovine besnoitiosis |
| Birnavirus (Infectious Bursal Disease) | Virus | P | Gumboro disease, IBD, IBDV |
| Borna Disease Virus (BDV) | Virus | E | Borna disease |
| Borrelia afzelii | Bacteria | DC | dermatitis, arthritis |
| Borrelia burgdorferi | Bacteria | DCREO | Lyme Disease |
| Borrelia garinii | Bacteria | DC | Meningopolyneuritis |
| Borrelia japonica | Bacteria | DC | Lyme disease |
| Bovine Ephemeral Fever Virus (BEFV) | Virus | O | Ephemeral fever |
| Bovine Papilloma Virus | Virus | E | warts |
| Bovine spongiform encephalopathy (BSE) | Protozoa | O | neurodegenerative disease |
| Canine Herpesvirus (CHV) | Virus | D | Herpes sores, kennel cough |
| Capnocytophaga canimorsus | Bacteria | DC | fulminant sepsis |
| Capripoxvirus | Virus | O | Lumpy Skin Disease |
| Chicken Anemia Virus (CAV) | Virus | P | anemia |
| Crimean-Congo Hemorrhagic Fever (CCHF) | Virus | DRO | Hemorrhagic fever |
| Cryptosporidium canis | Protozoa | D | Cryptosporidiosis |
| Cryptosporidium felis | Protozoa | C | Cryptosporidiosis |
| Cryptosporidium parvum | Protozoa | DCEO | Cryptosporidiosis |
| Cryptosporidium spp. | Protozoa | BS | Cryptosporidiosis |
| Duvenhage virus | Virus | D | bat rabies, human rabies |
| Eastern Equine Encephalomyelitis (EEE) | Virus | DBRE | Encephalitis |
| Echinococcus spp. | Helminth | DR | Echinococcosis |
| Ehrlichia canis | Bacteria | DO | Ehrlichiosis, anaplasmosis |
| Ehrlichia chaffeensis | Bacteria | DRO | Ehrlichiosis, anaplasmosis |
| Ehrlichia ewingii | Bacteria | O | Ehrlichiosis, anaplasmosis |
| Ehrlichia ruminantium | Bacteria | O | Heartwater, cowdriosis |
| Eimeria spp. | Protozoa | P | Coccidiosis |
| Encephalitozoon cuniculi | Protozoa | R | microsporidiosis |
| Encephalitozoon intestinalis | Protozoa | R | microsporidiosis |
| Encephalitozoon hellem | Protozoa | R | microsporidiosis |
| Equine Herpes Virus (EHV) Type 1 | Virus | E | colds, fever, rhinopneumonitis |
| Equine Herpes Virus (EHV) Type 3 | Virus | E | colds, fever, rhinopneumonitis |
| Equine Herpes Virus (EHV) Type 4 | Virus | E | colds, fever, rhinopneumonitis |
| Equine Infectious Anemia Virus | Virus | E | Anemia |

## Appendix A: Nonairborne Zoonotic Pathogens and Allergens

| PATHOGEN | Group | Host | DISEASE |
|---|---|---|---|
| Equine Rabies | Virus | E | rabies |
| Erysipelothrix rhusiopathiae | Bacteria | S | Erysipelas |
| Escherichia coli | Bacteria | DCBPES | various, colibacillosis |
| Escherichia coli F4 | Bacteria | S | diarrhea |
| Escherichia coli F5 | Bacteria | S | diarrhea |
| Feline Immunodeficiency Virus (FIV) | Virus | C | Immunodeficiency |
| Feline Leukemia Virus (FeLV) | Virus | C | Leukemia |
| Feline Spongiform Encephalopathy (FSE) | Protozoa | C | Scrapie, neurodegeneration |
| FMD virus (Aphthovirus Picornaviridae) | Virus | SO | Foot and Mouth Disease |
| Giardia duodenalis | Protozoa | O | Giardiasis |
| Giardia intestinalis | Protozoa | O | Giardiasis |
| Giardia lamblia | Protozoa | O | Giardiasis |
| Giardia spp. | Protozoa | DCBR | Giardiasis |
| Helicobacter pylori | Bacteria | DC | digestive illness |
| Hepatitis E Virus (HEV) | Virus | S | fever |
| Hippobosca longipennis | Insect | DC | Infestation |
| Ibadan shrew virus | Virus | D | rabies-like infection |
| Isospora spp. | Protozoa | DC | Coccidiosis |
| Ixodes ricinus | Insect | DCR | Infestation |
| Japanese Encephalitis | Virus | DCRE | Encephalitis |
| Lawsonia intracellularis | Bacteria | S | proliferative enteritis (PE) |
| Leishmania spp. | Protozoa | DCR | Leishmaniasis |
| Leptospira spp. | Spirochete | DCRO | Leptospirosis |
| Lymphoid Leukosis virus | Virus | P | Leukosis |
| Mokola virus | Virus | D | rabies-like infection |
| Mycobacterium lepraemurium | Bacteria | R | leprosy |
| Mycobacterium microti | Bacteria | R | leprosy |
| Mycoplasma haemocanis | Bacteria | DC | haemobartonellosis |
| Neorickettsia helminthoeca | Bacteria | D | Ehrlichosis |
| Neorickettsia risticii | Bacteria | E | Potomac Horse Fever |
| Neorickettsia sennetsu | Bacteria | O | Ehrlichiosis, anaplasmosis |
| Neospora caninum | Protozoa | D | ascending paralysis |
| Notoedres cati | Insect | R | infestation |
| Ornithonyssus sylviarum | Insect | R | infestation |
| Ornithonyssus bacoti | Insect | R | infestation |
| Pacheco's Disease virus (Herpesvirus) | Virus | B | viral hepatitis |
| Parasitic Feather Mites (Red Mite) | Insect | B | skin infestation |
| Pasteurella multocida (& other spp.) | Bacteria | DCBPRSO | Pasteurellosis, fowl cholera |
| Porcine Circovirus Type 2 | Virus | S | PMWS |
| Porcine Epidemic Diarrhea (PED) virus | Virus | S | Diarrhea, (Coronavirus) |
| Porcine Parvovirus (PPV) | Virus | S | Parvovirosis |
| Rickettsia rickettsii | Bacteria | DR | Rocky Mountain Spotted Fever |
| Rift Valley Fever | Virus | DCRO | Infectious Enzootic Hepatitis |
| Rotavirus | Virus | S | diarrhea |
| Salmonella arizona | Bacteria | B | Arizonosis |
| Salmonella bongori | Bacteria | DCRS | Salmonellosis |
| Salmonella enterica | Bacteria | DCRSO | Salmonellosis |
| Salmonella pullorum | Bacteria | P | Pullorum disease |
| Sarcocystis falcatula | Protozoa | DCBR | Sarcocystosis |

## Appendix A: Nonairborne Zoonotic Pathogens and Allergens

| PATHOGEN | Group | Host | DISEASE |
|---|---|---|---|
| Sarcoptes spp. | Insect | D | Acariasis, scabies |
| Scaly Face (Leg Mite) | Insect | B | Infestation |
| Screwworm Myiasis | Insect | DCR | infestation |
| Streptococcus equi | Bacteria | EO | Strangles, Streptococcosis |
| Strongyloides spp. | Helminth | DC | Larva Migrans |
| Surra | Protozoa | DCRO | Trypanosomosis |
| Swine Vesicular Disease Virus (SVDV) | Virus | S | Swine vesicular disease |
| Taenia spp. | Helminth | DCR | Taeniasis |
| Taylorella equigenitalis | Bacteria | E | Contagious Equine Metritis (CEM) |
| Togaviridae alphavirus | Virus | E | Encephalitis |
| Toxocara spp. | Nematode | DCR | Toxocariasis |
| Toxoplasma gondii | Protozoa | DCRS | Toxoplasma infection |
| Transmissible gastroenteritis virus | Virus | S | diarrhea |
| Tritrichomonas foetus | Protozoa | O | Trichomoniasis |
| Trichomonas gallinae | Protozoa | B | Trichomoniasis, cankers |
| Trichuriasis | Nematode | D | Whipworm infestation |
| Trixacarus caviae | Insect | R | infestation |
| Tritrichomonas foetus | Protozoa | DC | infestation |
| Trypanosoma cruzi | Protozoa | DCR | Trypanosomiasis |
| Venezuelan Equine Encephalomyelitis (VEE) | Virus | DRE | Encephalitis |
| Vesicular Stomatitis (VSV) | Virus | DREO | ulcers, lesions, fever |
| Wesselsbron Disease | Virus | DREO | flu-like illness |
| West Nile Virus | Virus | DCBRE | flu-like illness |
| Western Equine Encephalomyelitis (WEE) | Virus | DRE | Encephalitis |
| Brachyspira hyodysenteriae | Bacteria | S | dysentery |
| Campylobacter fetus | Bacteria | O | Campylobacteriosis |
| Corynebacterium bovis | Bacteria | R | hyperkeratosis |
| Corynebacterium kutscheri | Bacteria | R | pseudotuberculosis |
| Haemophilus parasuis | Bacteria | S | Glasser's Disease |
| Herpes virus BHV-1 (IBR virus) | Virus | O | Infectious bovine rhinotracheitis |
| Ibaraki virus | Virus | O | Ibaraki Disease |
| Junin virus | Virus | R | hemorrhagic fever |
| Klebsiella orthinolytica | Bacteria | R | pneumonia |
| Klebsiella oxytoca | Bacteria | R | pneumonia |
| Klebsiella planticola | Bacteria | R | pneumonia |
| Morbillivirus | Virus | O | Rinderpest |
| Mousepox | Virus | R | pox |
| Mycoplasma mycoides | Bacteria | O | Contagious bovine pleuropneumonia |
| Pestivirus | Virus | SO | Classical Swine Fever, BVD |
| Pneumonia Virus of Mice (PVM) | Virus | R | pneumonia |
| Pseudocowpox | Virus | O | viral skin disease |
| Rhadinovirus | Virus | O | Malignant catarrhal fever (MCF) |
| Sendai | Virus | R | Sendai disease |
| Staphylococcus hyicus | Bacteria | S | Epidermitis |
| Streptococcus canis | Bacteria | O | Streptococcosis |
| Streptococcus iniae | Bacteria | O | Streptococcosis |
| Streptococcus suis | Bacteria | SO | URD, Streptococcosis |

**NOTES for Appendix A:**

D = Dog
R = Rodent
S = Swine
C = Cat
E = Horses
O = Cow, Bovine
P = Poultry (non-pet)
B = Bird (pets)