Lumalier Use of UVGI Inside HVAC Air Handling Units
Coil and Drain Pan Surface Disinfection & Airborne Disinfection for SARS-CoV-2

March 2021

Coil and Drain Pan Surface Disinfection

The HVAC Industry commonly uses UVC for surface disinfection on coils and drain pans to eliminate microbial growth.

Specific Design Information using UVC to clean coils and drain pans:

1. ASHRAE Recommends 50 µW/cm² to 100 µW/cm² for Coil Cleaning (2019 ASHRAE Handbook Chapter 62 Section 4 Paragraph 3).
2. If the surface being treated with UVC is static (coil and drain pan), then the dosage calculations in µW/cm² are equal to the dosage calculations in µJ/cm².
3. 50 µW/cm² is equal to URV-5 (see chart).
4. 100 µW/cm² is equal to URV-7 (see chart).
5. Air Handling Unit Specifications will often specify a Dosage Rate for Coil Cleaning.

UVGI Rating Values (URV)

URV	Dose J/m²	Dose µW-s/cm²
1	0.01	1
2	0.10	10
3	0.20	20
4	0.30	30
5	0.50	50
6	0.75	75
7	1.0	100
8	1.5	150
9	2.5	250
10	5	500
11	10	1000
12	15	1500
13	20	2000
14	30	3000
15	40	4000
16	50	5000
17	60	6000
18	80	8000
19	100	10000
20	200	20000
21	300	30000
22	400	40000
23	500	50000
24	1000	100000
25	2000	200000

Note: URV 21-25 are newly appended URV definitions.

Source: Appendix G of Ultraviolet Handbook by Kowalski

Air Disinfection (Kill on the Fly)

UVC is an effective pathogen disinfection strategy for "Kill on the Fly" inside of air handling units or ductwork. This strategy is discussed in:

- 2019 ASHRAE Handbook Chapter 62
- 2020 ASHRAE Handbook Chapter 17

and in greater detail in the

- Ultraviolet Germicidal Irradiation Handbook by Wladyslaw Kowalski

Design Steps for a UVC Air Disinfection System are:

1. Determine the air velocity through the plenum or ductwork. This is typically measured in feet per minute (fpm).
2. Determine the distance that SARS-CoV-2 will be exposed to UVC light. Example: For draw through air handling units, this will be the distance between the downstream side of a cooling coil bank and the intake of a supply fan section (commonly referred to as a plenum section).
3. Calculate the dwell time. How long will the pathogen be exposed to the UVC light within the plenum?
4. Calculate the required irradiance. Researchers have determined (noted by IUVA and also in Appendix B of the Kowalski Handbook) that a total dose (intensity x time) of 3,000 µJ/cm² provides a 99.9% reduction (disinfection) of airborne coronavirus. Airborne pathogen reduction increases by one log per air pass (1-log = 90% reduction =, 2-log = 99% reduction, 3-log = 99.9% reduction, etc.) each time that the intensity is doubled. Based on accepted research, a dose of 750 µJ/cm² provides 90% coronavirus disinfection (conservatively), 1,500 µJ/cm² provides 99% disinfection, and a 3,000 µJ/cm² dosage provides 99.9% disinfection.
5. Determine the URV requirement. URV rating Value (URV) is in appendix G of the Kowalski Handbook. Note that URV ratings = UV intensify x one second of dwell time (one second @ 500 FPM = 8.33 feet of duct). If available duct size is less than 8.33 feet, the overall intensity must be increased to the equivalent intensity of a higher URV fixture (see # 2 and #3 on the next page).

6. Size the dosage without reflectivity.
7. Determine the reflectance of the material, if there is a liner (inner wall). Ultraviolet material reflectivities is in Appendix F of the Kowalski Handbook.
8. Resize the system taking into consideration reflectivity.

Example #1

Design Parameters:

1. 90% disinfection
2. 30,000 CFM
3. Coil fin height is 6′ (72″)
4. Coil width is 10′ (120″)
5. Airstream velocity is 500 FPM (30,000 CFM / 60 Sq Ft of Coil)
6. Plenum where UVC is installed is 24″ long in direction of airflow (distance between coil and fan inlet in a draw thru configuration)

Steps for URV Calculation to Size System:

1. **Calculate Required Irradiance to achieve 90% COVID-19 Inactivation.** The known, accepted UVC irradiance required to inactivate COVID-19 @ 90% is 750 μJ/cm² (also as per Kowalski's documents). 750 μJ/cm² requires URV-11, the equivalent to a dose of 1000 μW/cm² *over one second*.
2. **Calculate available dwell time (exposure to UV light).** At 500 FPM, air moves at 8.33 FPS. If only 2 feet of space is available between the coil and fan, 2'/ 8.33 FPS = 0.24 seconds of exposure.
3. **Size UVC fixture.** The required dosage to achieve 90% COVID-19 reduction per air pass is 750 μJ/cm². Because available dwell time is only 0.24 seconds (intensity x dwell = dose), inactivation requires 4 x 750/cm² to achieve the total required irradiance, or 3000 μW/cm². The dose intensity as listed for a URV-14 fixture is 3000 μJ/cm², so use URV-14 sizing equivalent to achieve 90% COVID-19 reduction in only 0.24 seconds.
4. Galvanized steel is known to reflect UVC energy by 57%. Using the reflectance of a galvanized steel liner to calculate the required UVC level means that a lower URV equivalent can achieve a 90% reduction in the available space. 3000 μW/cm² (the required lethal dose in 0.24 seconds) / 1.57 = 1910 μW/cm², or the equivalent of a URV-13 @ 2000 μJ/cm². Including reflectivity in the sizing calculation means that lower intensity URV level can be used, in this case a 2000 μJ/cm², or URV-13 to achieve 90% COVID-19 reduction with a galvanized steel liner.
5. If the liner is stainless-steel, then reflectance is increased by 30% and must be 'corrected' to determine the proper URV sizing to achieve 90% COVID-19 reduction. (3000 μW/cm²) / (1.3) = 2307 μW/cm² in the available space. This is the equivalent to the overall dose intensity as listed for a URV-14 fixture, so use URV-14 sizing to achieve 90% COVID-19 reduction with a stainless-steel liner.

Example #2

Design Parameters:

1. 99% disinfection
2. 30,000 CFM
3. Coil fin height is 6′ (72″)
4. Coil width is 10′ (120″)
5. Airstream velocity is 500 FPM (30,000 CFM / 60 Sq Ft of Coil)
6. Plenum where UVC is installed is 24″ long in direction of airflow (distance between coil and fan inlet in a draw thru configuration)

Steps for URV Calculation to Size System:

1. **Calculate Required Irradiance to achieve 99% COVID-19 inactivation.** The known, accepted UVC irradiance required to inactivate COVID-19 @ 99% is 1500 μJ/cm² (also as per Kowalski's documents). 1500 μJ/cm² requires URV-12, the equivalent to a dose of 1500 μW/cm² *over one second*.
2. **Calculate available dwell time (exposure to UV light).** At 500 FPM, air moves at 8.33 FPS. If only 2 feet of space is available between coil and fan, 2'/ 8.33 FPS = 0.24 seconds of exposure.
3. **Size UVC fixture.** The required dosage to achieve 99% COVID-19 reduction per air pass is 1500 μJ/cm². Because available dwell time is only 0.24 seconds (intensity x dwell = dose), inactivation requires 4 x 1500 μJ/cm² to achieve the total required irradiance, or 6000 μW/cm². The dose intensity as listed for a URV-17 fixture is 6000 μJ/cm², so use URV-17 sizing equivalent to achieve 99% COVID-19 reduction in only 0.24 seconds.
4. Galvanized steel is known to reflect UVC energy by 57%. Using the reflectance of a galvanized steel liner to calculate the required UVC level means that a lower URV equivalent can achieve a 99% reduction in the available space. 6000 μW/cm² (the required lethal dose in 0.24 seconds) / 1.57 = 3821 μW/cm², or the equivalent of a URV-15 @ 4000 μJ/cm². Including reflectivity in the sizing calculation means that lower intensity URV level can be used, in this case a 4000 μJ/cm², or URV-15 to achieve 99% COVID-19 reduction with a galvanized steel liner.
5. If the liner is stainless-steel, then reflectance is increased by 30% and must be 'corrected' to determine the proper URV sizing to achieve 99% COVID-19 reduction. (6000 μW/cm²) / (1.3) = 4615 μW/cm² in the available space. This is the equivalent to the overall dose intensity as listed for a URV-16 fixture, so use URV-16 sizing to achieve 99% COVID-19 reduction with a stainless-steel liner.