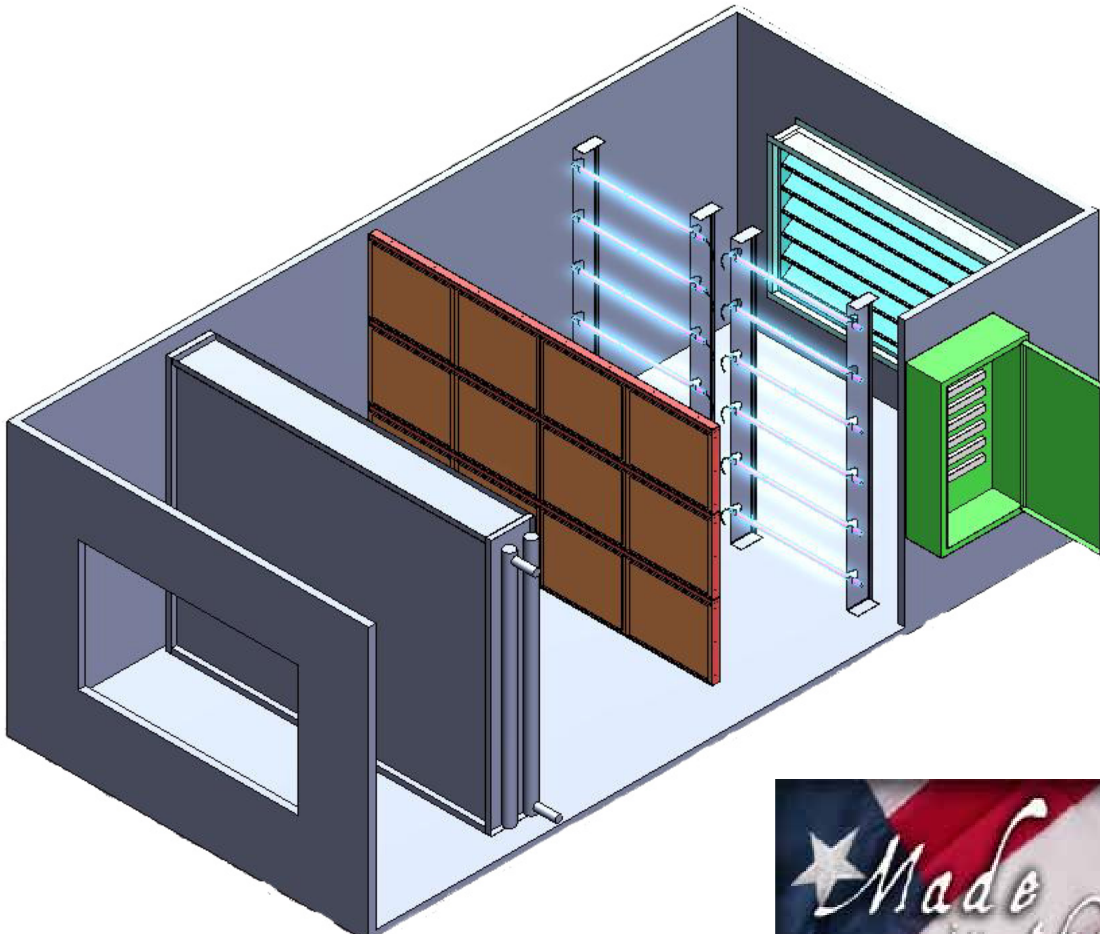
Concepts and Designs Inc.

Ultra Violet Germicidal Irradiation Systems

Installation Operation
And
Maintenance Manual



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IMPORTANT: Anyone responsible for the installation, maintenance or operation of this equipment must have a through understanding of the instructions and safety requirements before attempting to install or service this unit.

Keep this Manual Handy

ULTRAVIOLET

1. CDI UVGI SPECIFICATION:

UVC Germicidal Irradiation system shall be selected, designed, installed, wired, commissioned and warranted by the air handling unit manufacturer, for single source responsibility. UV system shall be powered from by the air handling unit power supply, and shall not require any external electrical supplies or connections.

Emitter shall be high intensity type, suitable for HVAC applications. UVC lamps shall be high output, T5 tube diameter, medium by-pin, and shall be constructed from hard glass tubing for superior UV transmittance. UVC lamps shall produce no ozone.

Emitter shall be encapsulated in a sealed quartz tube, and shall be water tight and dust tight and capable of being washed down while in the unit. Lamps shall be positioned inside the quartz sleeve using spacer rings. The end of the lamp shall be protected from the HVAC environment by a slip-fit boot that fits over the end of the quartz insulating sleeve. The assembly of the emitter in the quartz sleeve shall be supported by holding brackets constructed of hospital grade stainless steel.

Lamp fixtures shall be capable of being mounted horizontally or vertically to provide a proper spread of UVC across the target area. Lamps shall be rated to produce 10 microWatts/cm^2 per linear inch of lamp arc length at a distance of one meter, as independently tested in airstreams of 400 feet per minute air velocity at 45 degrees F.

The solid-state electronic ballast shall be a class P rapid start with minimum power factor of .95. The ballast shall be designed to maximize photon production in air temperatures of 35 to 175 degrees F. Minimum ballast start temperature shall be 20 degrees F. Ballast shall have an RFI EMI rating as defined by FCC part 18A for industrial/commercial applications in regards to suppression, and shall be UL listed.

Power source for the UVC lamps shall be remote mounted in the air handling unit electrical enclosure. The enclosure shall be NEMA 12 (or optional NEMA 3R) and shall be furnished and installed by the air handling unit manufacturer.

2. AIR HANDLER UV GERMICIDAL IRRADIATION

One of the purposes of installing UV-C is to eliminate mold and mildew growth at the coil and drain-pan areas. Typically UV-C germicidal fixtures are installed immediately downstream of the coil section of the air handling unit. Molds and mildew thrive in these environments and, if left unchecked, can result in lowered efficiency of the heat exchange unit through growth build up as well as increased odors and distribution of the mold, mildew, bacteria and viruses throughout the air duct system.

By installing UV-C germicidal fixtures in the area of the coil and drain pan, the efficiency of the heat exchange is increased by the reduction of growth on the coils. This also results in reduced pressure drop through the system. Drain pans, when continually exposed to UV-C, will not have growths that can result in blockages of drains or in odors being transmitted, eliminating the need for chemical treatments and periodic manual cleaning.

In addition, by installing UV-C germicidal fixtures in the air handling system, a reduction in airborne bacteria and virus counts is accomplished by installing sufficient UV-C dosage in the actual air stream to sterilize the flow as it passes by.

Concepts & Designs, Inc.'s UV-C fixtures installed at the coil and drain pan area and/or directly in the air ducting will result in the highest reduction of molds, mildew, bacteria, viruses and other airborne particle toxins and allergens.

Keep in mind CDI can custom design any type of UV unit to fit your need!

3. DESIGN CONSIDERATIONS

Racks and lamp lengths can be custom designed for any application

Dirty Socks?

Nearly every service technician has had the experience of starting an air handler and being greeted by an odor one could only describe as a "locker room." This experience, also known as the "dirty socks syndrome," is first-hand evidence of what happens when mold grows on the coil and in the drain pan of an air-conditioning unit. Every service technician has also had the experience of opening a unit to find the drain pan and coil covered with a slimy residue.

These conditions can be as unhealthy for building occupants as they are unpleasant. While the smell associated with mold growth is a bad situation, mold growth on coils also has a detrimental effect on system performance. This degradation of performance ultimately leads to higher energy costs and poor cooling performance.
Numerous coil-cleaning methods have been used to control this problem. Some of those techniques involve the use of detergents or even solvents, which can pose safety issues – health and flammability, for example – and diminish the life of the coil, because sometimes acids are involved. Often coil cleaning isn't done with regularity and even when it is done on schedule, the mold growth can return in a very short time.

The Benefits of UVGI (Ultraviolet Germicidal Irradiation)

The application of C-band ultraviolet light (UV-C) technology in air-handling systems now allows for a proactive method of keeping the coil clean and operating in "as new" performance all the time. UV-C lights can be added to CDI air handlers and other pieces of equipment as a factory-installed options.

Interestingly, while UV-C light has been promoted for its positive impact on indoor air quality (IAQ), the "bottom line" impact – its contribution to system efficiency and lower maintenance costs – might ultimately be considered to be its greatest asset.

4. WHAT CAUSES THE BUILD-UP?

Four conditions will result in mold and fungus growth:

1. A source of mold spores. Sufficient mold spores are found in nearly every environment and brought into the building through door openings and outdoor air supplies.

2. Organic material on which the mold can grow. Dust and particles of organic material are also readily available in every system, even with the best filtration systems.

3. The right temperature range. Temperatures from 50° F to more than 100° F provide the right incubation range.

4. Moisture, which is in more than adequate supply on cooling coils and drain pans of all air conditioning units.

Even when filtration is provided, a large part of the build-up on the cooling coil is the result of biological growth.

What are the effects of the build-up?

The odors associated with this problem stem from the natural growth and decay of mold. As the molds break down they decay into toxins and volatile organic compounds (VOCs), which cause the characteristic odor. In addition, some people have allergic reactions to these toxins and VOCs. These problems certainly contribute to poor building IAQ, but mold growth can impact energy use through lost performance as well.

5. EFFECTS OF BIO-FILM GROWTH ON A COOLING COIL

Bio-film growth can have a tremendous impact on coil velocity, putting it considerably off design specification. A good rule of thumb for evaporator coil size is about one sq ft. of face area per ton and 400 cfm per ton. If we consider that a 10-ton unit coil has 10 sq ft. of surface and 4,000 cfm (400cfm/ton x 10 ton), our gross face velocity is 400 ft per minute. But this is not the actual velocity through the coil. The fin and tube material takes up a very large portion of the coil.

Let's consider that our coil is a typical 14 fin/in. three-row coil with 3/8-in. tubes. The material in the face of the coil is considerable. With a 0.0055 in. fin thickness, the fin material alone reduces the free area by 8 percent (14 fins/inch x 12 inches/ft x 0.0055 fin thickness divided by the 144 inches/sq ft.). If we also consider that there are 12 tubes in a one-ft. high section, we reduce the free area by 37 percent more. The actual free area is now only 5.78 sq ft. and the resultant net face velocity is 692 ft/min.

How does a bio-film build-up affect the performance? If the bio-film thickness is .002 in. on the fin and tube surfaces, this will reduce the free area to 5.38 sq ft. and a velocity of 744 ft/min. What will an increase of 50 fpm mean to static? From a typical unit coil performance this can result in an increase of static of 16.5 percent.

However, unless the supply fan is on a variable frequency drive (VFD), the result is not an increase in motor horsepower, but instead results in a decrease in supply air. In our case, the supply airflow decreased by 9 percent to 3,650 cfm to regain system balance. Performance of a cooling coil is a function of the amount of coil surface, the amount of time the air is in contact with the surface and the heat transfer coefficient between the fin, tube and the air.

From a performance side, what does it mean to decrease the airflow by 9 percent? If we look at performance for a 10-ton coil we lose about 3 percent in total capacity. This analysis looks only at the affects of increased velocity. If we consider the effects on the heat transfer coefficient, the performance loss will be even more dramatic.

6. USING UV LIGHT TO CLEAN COILS

Coil cleaning can bring performance back to the original operating conditions. Typical coil cleaning methods include chemical treatments and steam cleaning. However, recent evidence suggests that both methods can be ineffective. Chemical cleaning may only remove surface growth while leaving material still embedded in the center of the fin pack. Some reports indicate steam cleaning can actually force the surface growth deeper in the fin pack compressing the growth material so tightly that the only solution may be a new coil. Both methods can also be detrimental to some of today's enhanced coil surfaces.

Coil cleaning is certainly necessary, but cannot be done economically with the frequency and level that will keep the coil operating at design conditions on a daily basis. In essence, with UV-C lights, coil cleaning becomes a continuous, automatic and labor-free alternative. The UV-C light works by attacking the DNA of the mold and rendering it sterile so that it can not reproduce.

Contrasting physical cleaning methods to the use UV-C light is analogous to the difference between treating the symptoms and curing the disease.

UV-C technology is not new, as it has proven itself for years as a way to provide sterilization in medical and food processing applications. What is new, is the development of high-energy output UV-C lights from CDI that can achieve very high mold kill rates under the cold temperature and rapid air velocity conditions of an HVAC system.

The effectiveness of the UV-C light is a function of the light intensity, the reflectivity of the space and the distance from the light. In general, if the mold is exposed to the light for a brief period of time, it will be destroyed. Aluminum coil fins are a good reflective surface and, as a result, the UV-C energy is capable of penetrating three- and four-row coils with excellent results.

Given continuous exposure, UV-C lights can clean up a coil already contaminated by mold growth and keep the coil cleaner than other methods.

7. THE PROOF IS IN THE PERFORMANCE

While UV-C light is an emerging technology for the HVAC business, it is already starting to prove its effectiveness. For example, an air handler in an office building in Los Angeles exhibited the classic problems of bioaerosol film growth. The air handler involved demonstrates the degree of the problem. Mold growth was evident both on the coil and in the drain pan.

The unit was equipped with a bank of UV-C lights, and its operation was monitored for 30 days. Within 30 days, the unit was operating at near design conditions. The coil pressure drop decreased by 28 percent, resulting in 8.6 percent improvement in airflow. The coil dry bulb depression had increased by nearly 4° F, providing more than five tons of sensible cooling.

Wet bulb depression also increased by 1.8° F, enabling a total capacity increase of seven tons. Continued use of the light bank kept the air handler operating at the design conditions.

Other buildings have experienced similar results. A southwestern utility company applied UV-C lights to the air handlers in its headquarters office building. The city went through one of its hottest summers ever. In previous years the standby chiller was required just to keep up with the load. However, with the now-clean coils, the extra chiller was never required during the extremely hot summer.

In most office buildings, the demand-charge savings alone from this improvement would result in significant savings. Reduced maintenance costs and improved IAQ are a welcome bonus.

8. HOW THE UV-C LIGHT IS APPLIED

The ideal location for the UV-C light is on the discharge side of the cooling coil and mounted so as to expose both the coil surface and drain pan to as much light as possible. In general, the light should be positioned about a foot from the coil surface. As a rule of thumb, the number of lights can normally be based on one light for each five sq ft. of coil.

The light used for UV-C is not dangerous, but some common sense installation safety precautions should be followed when the light is installed. As the UV-C light is similar to the UV light used for tanning beds, but its wave band is of a level such that it does not pose an exposure risk to humans. Selecting the right light, however, is important. In an HVAC environment, a traditional UV-C light may lose much of its effectiveness because the light is located in a cold area with air movement over the coil.

9. SOME CAUTION IS REQUIRED

Care must be taken to assure that materials exposed to the UV light – particularly wiring and plastic materials – are UV stabilized so they will not degrade over time. While the concept is simple, reliable performance depends on applying lights designed for this application and applying them in units where the safety and compatibility issues have been evaluated.

Typical operation for the UV-C light is to run the light whenever the fan is operating. Under normal operation, the light will provide the required output for about one year of service, at which time a simple change-out is required.

10. PAYBACK

Technology can be a great thing, but to the user, the real question is: does this investment pay off? Assume that the first cost of installing two typical lights for our 10-ton example unit is $400. Also assume that it takes one hour to install them, so the installed cost is approximately $500. Contrast this with the cost of manually cleaning the coils. Based on coil cleaning costs from one service company, our 10-ton coil would cost $250 to clean. If we could actually get the coil cleaned three times in a year, which is probably a minimum, the annual coil cleaning expense would be $750. Since the bulb would be replaced on an annual basis at a cost of about $100, then our investment should repay itself in less than one year – just based on maintenance costs. If you consider the energy savings, the payback can be reduced to a fraction of that.

11. NO MORE DIRTY SOCKS

Shedding a little UV-C light on the subject of HVAC systems provides a method of proactive coil cleaning that can keep coils operating at near design conditions year round. Coils kept clean of a bioaerosol film perform far better, saving energy and avoiding the odors associated with a locker room. Reducing energy costs and improving air quality for building occupants creates the ideal scenario for any building owner or manager.

12. CDI ULTRAVIOLET GERMICIDAL IRADIATION (CDIUVGI) MODEL TYPES

The CDI UVGI systems are designed to destroy micro-organisms within AHU units. The Ultraviolet lamp peak radiation of 254 nanometer wavelength (nm) destroys or inactivates the DNA (deoxyribonucleic acid) which absorbs the Ultraviolet radiation. UVC emitter and fixture shall be factory assembled and tested. Emitter sockets and emitter shall be constructed to withstand HVAC environments. Each emitter will be installed in a quartz sleeve. All CDI UVGI emitters are designed to meet the disinfection requirements. Consult with CDI when selecting emitters for “Infectious Disease Control.”

Standard CDIUVST

This Model is intended to be installed within AHU areas that are not subject to moisture or corrosive containments. The emitters are rack mounted and subjected to air velocities below 500 Feet per minute (fpm). UVC emitter and fixture shall be factory assembled and tested. Emitter sockets and emitter shall be constructed to withstand HVACX environments. Each emitter will be installed in a quartz sleeve.

Drip Proof CDIUVDP

This Model is intended to be installed within areas that are subject to moisture or corrosive containments. The emitters are rack mounted and subjected to air velocities below 500 Feet per minute (fpm). UVC emitter and fixture shall be factory assembled and tested. Emitter sockets and emitter shall be constructed to withstand HVACX environments. Each emitter will be installed in a quartz sleeve. The emitter, quartz sleeve and emitter power cord are moisture proof and have no voids.

CDI UVGI APPLICATIONS

Ultraviolet (UV) radiation inactivates organisms by absorption of the light which causes a photochemical reaction that alters molecular components essential to cell function. As UV rays penetrate the cell wall of the microorganism, the energy reacts with the nucleic acids as well as other vital cell components, resulting in the injury or death of the exposed cells. CDIUVGI emitters are designed to produce 254 nm at the power level necessary to accomplish the microorganism injury or death.

The CDIUVST and DP Models are typically designed to treat cooling coils and air filters. Other application may include treatment of other AHU components such as drain pans and blowers.

13. INSTALLATION INSTRUCTIONS

CDIUVST Model

The emitter rack, emitter fixture, ballasts, emitters and wiring will be fully installed and tested at the factory. The emitters and emitter quartz sleeves will be *Shipped Loose* for installation in the field. Emitters and quartz sleeves are fragile and must be handled carefully. Clean cotton gloves must always be worn when handling these components.

1. Refer to the unit drawing UV details.
2. Remove the emitter and quartz sleeve from the shipping container.
3. Wipe the emitter and quartz sleeve with a clean cloth impregnated with isopropyl alcohol.
4. Slide the emitter into the quartz sleeve.
5. Clamp the quartz sleeve into the fixture, tightening the adjustable clamps just enough to hold the quartz sleeve in place.
6. Push the emitter electrical connector onto each end of the emitter making sure that the electrical plug sleeve is pushed onto the quartz sleeve.
7. Repeat this until all emitters are installed.
8. Push the emitter electrical connector onto each end of the emitter making sure that the electrical plug sleeve is pushed onto the quartz sleeve.
9. Repeat this until all emitters are installed.
10. Repeat the quartz sleeve cleaning procedure.

CDIUVDP Model

The emitter rack, emitter fixture, ballasts, emitters and wiring will be fully installed and tested at the factory. The emitters and emitter quartz sleeves will be *Shipped Loose* for installation in the field. Emitters and quartz sleeves are fragile and must be handled carefully. Clean cotton gloves must always be worn when handling these components.

1. Refer to the unit drawing UV details.
2. Remove the emitter and quartz sleeve from the shipping container.
3. Wipe the emitter and quartz sleeve with a clean cloth impregnated with isopropyl alcohol.
4. Slide the emitter into the quartz sleeve.
5. Place the emitter in the emitter rack opening.
6. Push the emitter electrical connector onto the end of the emitter making sure that the electrical plug sleeve is pushed onto the quartz sleeve.
7. Repeat this until all emitters are installed.
8. Push the emitter electrical connector onto each end of the emitter making sure that the electrical plug sleeve is pushed onto the quartz sleeve.
9. Repeat this until all emitters are installed.
10. Repeat the quartz sleeve cleaning procedure.

14. LAMP AND FIXTURE MAINTENANCE

Lamps and fixtures should be kept free from dust and film to provide maximum efficiency and output. With the lamps in the "OFF" condition, ultraviolet tubes and fixtures should be cleaned periodically with a clean cloth dampened with alcohol or ammonia and water.

Lamps should be changed when output of ultraviolet falls to 70% of original output. This can be ascertained by use of a special ultraviolet meter. Regular lamp change at one-year intervals will also insure adequate germicidal ultraviolet intensity. The calendar method is widely used and has proven satisfactory.

Ultraviolet rays cannot be seen by the human eye. The visible blue light, also emitted from germicidal ultraviolet lamps, will be seen long after the germicidal ultraviolet radiations have diminished to a non-effective level. Regular lamp replacement is most important for maximum efficiency and benefits of ultraviolet usage.

Concepts and Designs will send a replacement notification, on the calendar basis, to all users of germicidal ultraviolet. Also available is "Automatic Lamp Replacement Service", which provides receipt of new lamps when needed.

INTENSITY DATA

Incident energies of germicidal ultraviolet radiation at 253.7 nanometers necessary to inhibit colony formation in organisms (90%) and for complete destruction.

Energy needed for kill factor
Microwatt seconds per square centimeter

MOLD SPORES	Color	90%	100%
Aspergillius flavis	*Yellowish green*	60,000	99,000
Aspergillius glaucus	*Bluish green*	44,000	88,000
Aspergillius niger	*Black*	132,000	330,000
Mucor racemosus A	*White gray*	17,000	352,000
Mucor racemosus B	*White gray*	17,000	352,000
Oospora lactis	*White*	5,000	11,000
Penicillium expansum	*Olive*	3,000	22,000
Penicillium roqueforti	*Green*	13,000	26,400
Penicillium digitatum	*Olive*	44,000	88,000
Rhisopus nigricans	*Black*	111,000	220,000

ORGANISM	90%	100%
Bacillius anthracis	4,520	8,700
Bacillius magaterium sp. (spores)	2,730	5,200
Bacillius magaterium sp.(veg.)	1,300	2,500
Bacillius paratyphusus	3,200	6,100
Bacillius subtilis spores	11,600	22,000
Bacillius subtilis	5,800	11,000
Clostridium tetani	13,000	22,000

Energy needed for kill factor
Microwatt seconds per square centimeter

ORGANISM (continued)	90%	100%
Corynebacterium diphtheriae	3,370	6,500
Eberthella typosa	2,140	4,100
Escherichia coli	3,000	6,600
Leptospira Canicoal-infections Jaundice	3,150	6,000
Microccocus candidus	6,050	12,300
Microccocus spheroides	1,000	15,400
Myrobacterium tuberculosis	6,200	10,000
Neisseria catarrhalis	4,400	8,500
Phtomonas tumeficiens	4,400	10,000
Proteus vulgaris	3,000	6,600
Pseudomonas aeruginosa	5,500	10,500
Pseudomonas fluorescens	3,500	6,600
Salmonella enteritidis	4,000	7,600
Salmonella paratyphi-enteic fever	3,200	6,100
Salmonella typhosa-typhoid fever	2,150	4,100
Salmonella typhimurium	8,000	15,200
Sarcina lutea	19,700	4,200
Serratia marcescens	2,420	3,400
Shigella dysenteriae-Dyentery	2,200	4,200
Shigella flexneri-Dysentary	1,700	3,400
Shigella paradysenteriae	1,680	3,400
Spirillum rubrum	4,400	6,160
Staphylococcus albus	1,840	5,720

Energy needed for kill factor
Microwatt seconds per square centimeter

ORGANISM (continued)	90%	100%
Staphylococcus aureus	2,600	6,600
Streptococcus hemolyticus	2,160	5,500
Streptococcus lactis	6,150	8,800
Streptococcus viridans	2,000	3,800
Vibrio comma-Cholera	3,375	6,500

PROTOZA	90%	100%
Chlorella vulgaris(Algae)	13,000	22,000
Nematode eggs	4,000	92,000
Paramecium	11,000	20,000

VIRUS	90%	100%
Bacteriophage (E.Coli)	2,600	6,600
Infectious Hepatitis	5,800	8,000
Influenza	3,400	6,600
Poliovirus-Poliomyelitis	3,150	6,000
Tobacco mosaic	240,000	440,000

YEAST	90%	100%
Brewers yeast	3,300	6,600
Common yeast cake	6,000	13,200
Saccharamyces carevisiae	6,000	13,200
Saccharomyces ellipsoideus	6,000	13,200
Saccharomyces sp.	8,000	17,600

MAINTENANCE LOG

MODEL No. **SERIAL No.**

Date	Activity	Technician

Notes

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