

## UVGI in High-Humidity Applications

### The Challenge: Clean Air in Paradise

Balmy tropical breezes make living and working in Hawaii a pleasure, but large buildings like hospitals require year-round air conditioning to maintain comfort levels for patients and staff. High humidity levels bring many challenges including mold and bacteria that can proliferate in air conditioning units and ducts as well as in other building areas. The Queen's Medical Center in Honolulu has turned to ultraviolet germicidal irradiation (UVGI) to improve their air quality, protect against mold, bacteria, and airborne pathogens, and maintain energy efficiency.

### The Old Way

The Queen's Medical Center is a 530-bed acute care facility located in the heart of the city. The complex contains architecture ranging from the 1920s to today. Some of their older wings contained large motors for air conditioning equipment (125 hp (93 kW) and larger). And with thousands of patients, staff, and visitors coming and going daily, airborne pathogens such as those that can spread infectious diseases were a concern. The Queen's Medical Center and Hawaiian Electric Company (HECO) joined forces on a series of projects that would address many issues including energy and environmental concerns.

### The New Way

It has long been known that UV light in the "C" band kills microorganisms or prevents them from replicating. UVGI lights are used in homeless shelters, prisons, and clinics to help prevent the spread of infectious diseases. While there has been some concern that high humidity conditions can reduce UVGI's efficacy, many in the industry cite technology advances that enable UVGI fixtures to function effectively in high-

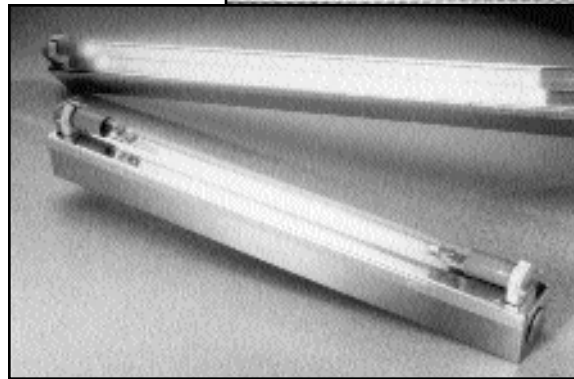
humidity conditions such as those found around air conditioning coils.

It was in just such a high-humidity environment that The Queen's Medical Center installed about 50 UVGI lamps. As part of the newly constructed Queen Emma Clinic, HECO encouraged Queen's to install UVGI lights inside three new air-handling units (AHUs) so that the coils, drain pan, and airstream were bathed in UVGI energy. The UVGI lights prevent slime, mold, and bacteria from forming on the coils and in the drain pan. Slime formation can reduce a coil's heat exchange efficiency by 30% or more within a year.

The size and number of lamps were selected to maintain an airborne kill ratio of 99%. This means that not only is energy efficiency maintained, each time air circulated through the air conditioning ducts, 99% of the airborne microbes are killed or inactivated. The size of these

three AHUs ranges from 20 to 30 tons. To safeguard against the spread of infectious diseases, UVGI lamps were also installed in the common areas of the new Queen Emma Clinic - in the waiting rooms and nurses stations as well as in some examination/isolation rooms. The clinic serves low-income families of Hawaii.

These light fixtures have baffles so that the UV light only shines along the ceiling. As the airborne bacteria pass near the ceiling, they are exposed to the UV light and are inactivated. Because of the high humidity found in Hawaii, about 15% more UV output was designed into the installation than would be used in dry environments. Queen's found that it was imperative to always energize the UVGI lamps whenever the air handling units are in operation. Failure to do so can cause water condensation within the fixtures and therefore possible lamp failure.



**The Queen's Medical Center in Honolulu has installed upper-air UVGI fixtures for individual room disinfection (above) and in air-handling units (left) to improve air quality, protect against surface mold and bacteria, kill or inactivate airborne pathogens, and maintain energy efficiency.**

Queen's was so pleased with the results of the UVGI equipment in the Queen Emma Clinic that the design of their new Same Day Surgery Unit and Emergency Center incorporated UVGI technology right from the outset of the design process. In addition, UVGI was installed in an air handling unit in the Business Services area that was being converted to variable air volume operation as part of the overall HECO-EPRI Healthcare Initiative project.

### What Did It All Cost?

The number and size of UVGI emitters depend on a number of factors that define the intensity/duration relationship. These factors include the kill ratio desired, the volume, velocity, and temperature of air to be treated, and any surface reflections. Vendor experience and support in these areas is critical to the success of the UVGI installation. At Queen's, HECO received support from both Commercial Lighting Design and Steril-Aire. EPRI helped by providing site tours of sites in New York City and Miami, where UVGI technology was already being used.

Typical mold control equipment costs for UVGI in a 20 to 30 ton AHU (8,000 to 12,000 CFM or 3.8 to 5.7 m<sup>3</sup>/s), would be \$2,000 to \$3,000. In a hospital environment focused on tuberculosis kill, this figure would be \$4,000 to \$6,000 or more. Annual maintenance costs would be about \$720 - \$1,080 and consist of changing the tube once a year.

Upper air UVGI fixtures cost about \$3

to \$5 per square foot (\$0.28 to \$0.46/m<sup>2</sup>) with annual maintenance cost of about \$0.50 to \$1.00/ft<sup>2</sup> (\$0.05 to \$0.09/m<sup>2</sup>). In general, fixtures for areas with higher ceilings are less expensive because their design can be simpler.

HECO-EPRI invested about \$40,000 in the UV installation in the Queen Emma Clinic at Queen's Medical Center. This included fixtures within air handlers as well as those for Upper Room UVGI. Installation costs were quoted at about \$75,000 by the general contractor. Total costs would thus be about \$115,000.

### The Bottom Line: More Efficient and Cleaner Operation

The work Queen's did with HECO resulted in immediate and predictable long-term energy savings along with less HVAC maintenance, higher efficiency, and fresher air. It now serves as a model to apply these technologies to other areas of the medical center.

- Before the UVGI emitters were installed inside the air handling units, Queen's had to clean and disinfect air conditioning coils and drain pans annually. The areas are inspected every three months but since UVGI was installed a year ago, no slime has grown and the system is operating at nearly 100% efficiency.
- Staff members and visitors notice that the air is fresher and cleaner - and without the musty odors often found in high-humidity environments.



**Queen's Medical Center Manager of Facilities, Scott Myhre, (left) and manager of HVAC, Ron Tolleson, are part of the team that brought cleaner and safer air to Queen's Medical Center buildings.**

### Role of the Electric Utility

Hawaii Electric Company, through information and publications from EPRI, was able to successfully implement UVGI for the benefit of Queen's Medical Center. HECO sponsored a seminar for physicians on UVGI at Queen's. They also purchased the fixtures for the UVGI projects, which were installed by the contractor already on the job at the Queen's Medical Center. The energy cost reduction for the new air conditioning equipment, variable speed motors, and direct digital controls is under evaluation by HECO.

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Photographs courtesy of HECO, page 1, above; Steril-Aire, page 1, left; The Queen's Medical Center, page 3.

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