A small-business guide

Medical Clinics

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Wayne Krill of EPRI manages the Electrotechnologies for Small Businesses project and directed development of this guide.

ABOUT THIS GUIDE

Members of the small-business community historically have had little contact with their utility providers. This guidebook was developed to facilitate communication between electric utilities and the medical clinics and healthcare practitioners in their communities.

The *Medical Clinics* guide is intended to familiarize readers with the business of operating an establishment that provides outpatient healthcare. The service providers include medical doctors, dentists, osteopaths, chiropractors, optometrists, podiatrists, and other healthcare practitioners. The guide summarizes the key business issues facing the industry and delineates how electric equipment can help address specific needs and interests of medical clinic owners and operators.

This business guide is one of a series of publications about small businesses produced by the Electric Power Research Institute (EPRI). The *Medical Clinics* guide is based on extensive and ongoing research and contains the latest information available at the time of publication. Nevertheless, it is a work in progress rather than a definitive and final document. The information and resources presented offer the reader a solid base from which to develop electricity-based solutions to energy and business needs.

The guide is organized as a reference document for use on an as-needed basis. Section tabs are included to facilitate quick access to topics of interest; icons representing energy end uses are also provided to help with locating complete information on electrotechnology solutions.

In 1992, nearly two-thirds of all healthcare dollars were spent in medical clinics—more than $215 billion dollars at roughly 396,000 establishments. That is a good income for these small businesses (more than 95% of all clinics have fewer than 20 employees). Furthermore, industry experts forecast an average annual growth rate of 13.5% through the 1990s for all healthcare expenditures.

While indeed in some senses the market is booming for medical clinics, given the aging of the U.S. population, high rates of crime-related injuries, and renewed threats of infectious disease, other factors are exerting an unprecedented economic squeeze. For a medical clinic to achieve robust economic health today demands not only skill and accuracy in the practice of medicine, but careful attention to the practice of business.

The key business issues for medical clinics today are managed competition and increased regulations designed to curtail the spread of infectious diseases. Managed competition pits the use of newly available sophisticated equipment and the threat of malpractice against insurers' requirements for efficiency and cost-containment. While insurers are rewarding budget-conscious businesses, new health and safety and environmental regulations covering handling and disposal of infectious waste are adding to clinic operating and labor costs. Medical clinic owners and operators are seeking strategies and tools to address these business challenges. The accompanying table identifies specific electrotechnologies that can help medical clinics reduce operating costs, safely dispose of infectious waste, and protect patient and employee health and safety. These electrotechnologies and other high-efficiency electric technologies are described in detail in the *Medical Clinics* guide (EPRI TR-106676-V4), which is available from the EPRI Distribution Center. To order this publication or other guides in the series, call the Center at (510) 934-4212.

Electrotechnologies for Medical Clinics

	Ultraviolet Disinfection of Air	Energy-Efficient Outdoor Lighting	Infrared Sterilization	Low-Volume Infectious Waste Treatment
Description	Short-wave UV-C light emitted by UV disinfection lamps kills microorganisms such as bacteria and viruses that are carried in the air and transmitted through ventilation systems.	Six different types of lighting technologies are available; each offers unique characteristics in wattage, brightness, light tone, efficiency, and lifespan; they can be combined to meet size-specific needs.	Infrared sterilization uses far-infrared rays to transfer heat directly to a waste load in a chaber; after cooling, the waste is crushed into a residue suitable for landfill disposal.	Four types of technologies are available for on-site disinfection of relatively small loads of most types of medical waste—chemical-mechanical, electrochemical, thermal-mechanical, and vacuum-steam.

Medical Clinic Need	Airborne diseases are on the rise; medical practitioners need to be able to treat those affected by disease as well as protect other patients and employees from airborne transmission of disease.	Lighting improves the visibility and attractiveness of a facility, enhances patient and employee safety, and reduces the potential for crime.	All medical clinics need safe, cost-effective methods for treating infectious waste; on-site treatment can minimize the risks and liabilities associated with third-party handling.	All medical clinics need safe, cost-effective methods for treating infectious waste; on-site treatment can minimize the risks and liabilities associated with third-party handling.
Application	To treat air in waiting areas, clinic rooms, hallways, or lab areas, UV lamps can be mounted on the ceiling, walls, or within ventilation ducts.	Signage on or near the facility; general lighting for driveways, walkways, delivery areas; facade and landscape lighting.	This method is suitable for sterilization of all but anatomical, radiological, or chemotherapeutic wastes; aerosol cans; or flammable hydrocarbons.	The thermal-mechanical method is appropriate for sharps and rigid plastic waste only; the other methods are suitable for most wastes except chemotherapeutic and pathology wastes and hazardous chemicals.
Benefits	UV-C light systems ensure against transmission of airborne disease, are easy to install, and are adaptable to most HVAC systems.	Increased public perception of quality, cleanliness, attractiveness from general signage and facade lighting; improved safety from area lighting.	This automated process is noiseless, odorless, provides for complete on-site sterilization with no emissions or effluent, and reduces the waste volume by 90%.	These automated processes provide for complete on-site sterilization of most kinds of infectious waste, enhancing employee and patient safety by allowing immediate off-site disposal.
Cost	Purchase and installation costs run $100-$500 per lamp; continuous use of three lamps to disinfect a 600-square foot space would require 790 kWh per year.	Systems are custom-designed to meet a facility's needs and budget.	The capital and operating cost of an infrared sterilization unit is about $60,000; the operating and maintenance cost of an average 20-lb load is $3.85.	The capital and operating costs vary significantly among the four technologies. System purchase costs range from $795 to $39,500 per unit.

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INTRODUCTION TO MEDICAL CLINICS

While the convention of doctors working in an institutional or hospital-like setting dates back to ancient Egypt, medical offices as independent establishments did not emerge until the Middle Ages. The first independently employed clinicians worked in offices or in patients' homes and received payment for services as they were provided. During the first half of the twentieth century in the United States, technical advances, such as the development of antibiotics, and public health initiatives increased physician effectiveness in many parts of the country while simultaneously decreasing the need for doctors in many respects.

Business Overview

During the second half of the twentieth century, technological developments increased physicians' roles in healthcare by improving their ability to detect and treat a wider variety of diseases. The total number of freestanding clinics also grew during this period. According to the National Center for Health Statistics, the number of people using the services of medical clinics and offices gradually increased during this time, with the largest increases occurring in or near cities.

Today, the healthcare industry is not only a leading contributor to both U.S. gross domestic product (GDP) and employment, but responsible for the mental and physical well-being of the population. In 1994, national healthcare expenditures—for health services, drugs and other medical nondurables, and medical durables—total nearly $1 trillion, representing more than 15% of GDP.

The key business issues facing medical clinics are structural/organizational changes in the marketplace that have increased operating costs, making it difficult for clinics to provide high-quality healthcare and make a profit. Other challenges include complying with environmental and health and safety regulations designed to prevent the spread of new and reemerging infectious diseases.

The term "medical clinic" refers to establishments providing outpatient healthcare. The service providers include doctors of medicine (SIC 8011), dentists (SIC 8021), osteopaths (SIC 8031), and healthcare practitioners such as chiropractors, optometrists, and podiatrists (SIC 8041–8043). According to the U.S. Department of Commerce, there were

396,233 medical clinics in 1993, nearly 80% of which were doctor and dentist offices (see Table 1). These establishments employed more than 2.5 million people and had annual receipts of more than $215 billion in 1993, a figure that represents more than 60% of the total receipts of SIC 80 (Health services, including medical clinics, hospitals, nursing and personal care facilities, medical and dental laboratories, and home healthcare services).

Medical clinics are traditionally small businesses; more than 95% of all medical clinics have fewer than 20 employees, and 99% have fewer than 50 employees. Even though medical clinics are small, they are employing growing numbers of people and have averaged 4% growth annually throughout the 1990s. Along with an overall expansion of the healthcare industry, jobs for physicians and other positions in medical clinics and offices are expected to continue to multiply in the latter part of the 1990s.

The majority of clinical physicians are self-employed and practice either independently or in a partnership or group that shares office space and medical assistants. During the 1980s, some physicians began to establish franchises across the country. The most widely recognized medical franchises are optical clinics such as Hour Eyes, Lens Crafters, and Pearle Vision Center.

In general, the larger the population of a state, the greater the number of medical clinics and offices located in the state. California is the top state for all of the medical clinic SIC codes, except for doctors of osteopathy (of which Michigan has more). Other states with high numbers of medical clinics include New York, Texas, Florida, Pennsylvania, Illinois, Ohio, New Jersey, Michigan, and Georgia (see Figure 1).

Table 1
Profile of the Medical Clinic Industry (1993)

Type of Practitioner	No. of Establishments	No. of Employees	Receipts ($ billions)
Doctors of Medicine (SIC 8011)	200,590	1,577,082	155.2
Dentists (SIC 8021)	109,818	581,378	39.2
Osteopaths (SIC 8031)	8,554	48,861	4.1
Chiropractors (SIC 8041)	28,288	89,177	7.1
Optometrists (SIC 8042)	17,054	71,672	5.7
Podiatrists (SIC 8043)	7,937	27,044	2.2
Other Health Practitioners (SIC 8049)	23,992	123,851	2.2
TOTALS	**396,233**	**2,519,065**	**215.7**

Source: U.S. Department of Commerce, Bureau of the Census, *Annual Survey of Manufactures, 1993 and County Business Patterns, 1993-United States*, CBP-93-1, 1996.

States	Clinics
CA	55,741
NY	30,306
TX	26,389
FL	26,182
PA	19,749
IL	16,810
OH	16,549
NJ	15,395
MI	14,084
GA	9,671

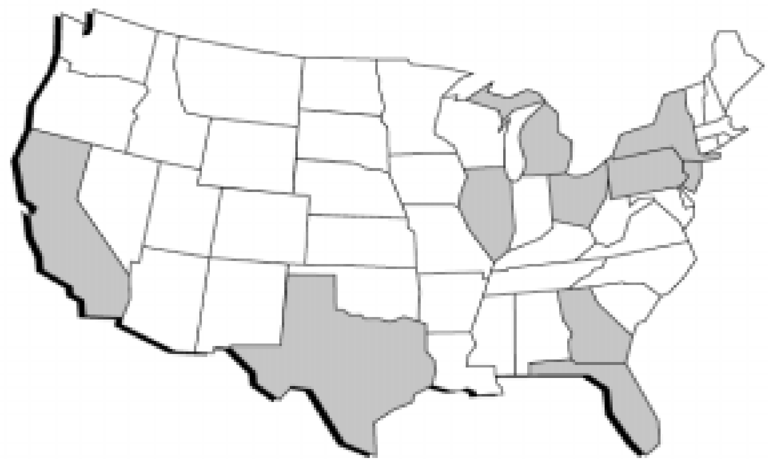


Figure 1
Top 10 States for Medical Clinics (1993)

Source: U.S. Department of Commerce, Bureau of the Census, *County Business Patterns, 1993-United States,* CBP-93-1, 1996.

Energy Use

While energy-use data do not exist for solo practitioners and other small medical offices, the available data on medical clinics shows that energy use varies widely, depending in part on the types of services that the clinic or office provides. Medical clinics typically operate five to seven days per week, one to one-and-a-half shifts per day Monday through Friday, and a half shift each day on the weekend. According to the U.S. Department of Energy, which collected information on the basis of whole-building energy use versus individual establishments, there were 43,852 outpatient clinic buildings in the United States in 1992 that together consumed approximately 60 trillion Btu of total energy. Natural gas (59%) and electricity (37%) represent the largest shares of energy use, while district heating (3%) and fuel oil (2%) account for the remainder.

Total electricity use in these medical clinic buildings in 1992 was equivalent to 6.5 billion kWh. Across the United States, the average electric intensity for all medical clinics is 13.5 kWh per square foot (see Table 2). This intensity is lower than for office buildings, hotels and motels, and shopping centers, but higher than the electric intensity for other commercial service facilities, such as drycleaners and auto body shops. On a regional level, medical clinics in the South and Midwest average a higher electricity intensity, due to their greater use of air conditioning.

Table 2
Electricity Consumption in Medical Clinics (1992)

Census Region and Division[1]	Total Electricity Consumption (thousand kWh)	Total Floor Space (thousand sq ft)	Total Electric Intensity (kWh/sq ft)
Northeast	**321,091**	**38,770**	**8.3**
New England	47,989	7,937	6.0
Middle Atlantic	273,102	30,833	8.9
Midwest	**2,731,967**	**185,460**	**14.7**
East North Central	1,751,284	100,698	17.4
West North Central	980,683	84,762	11.6
South	**1,810,874**	**111,293**	**16.3**
South Atlantic	959,664	83,913	11.4
East South Central	467,321	18,511	25.2
West South Central	383,889	8,869	43.3
West	**1,689,819**	**1,50,075**	**11.3**
Mountain	132,495	15,872	8.3
Pacific	1,557,324	134,203	11.6
TOTAL	**6,553,751**	**485,598**	**13.5**

[1]**New England:** CT, MA, ME, NH, RI, VT. **Middle Atlantic**: NJ, NY, PA. **East North Central**: IL, IN, MI, OH, WI. **West North Central:** IA, KS, MN, MO, NE, ND, SD. **South Atlantic**: DC, DE, FL, GA, MD, NC, SC, VA, WV. **East South Central:** AL, KY, MS, TN. **West South Central:** AR, LA, OK, TX. **Mountain**: AZ, CO, ID, MT, NM, NV, UT, WY. **Pacific**: AK, CA, HI, OR, WA.

Source: U.S. Department of Energy, Energy Information Administration, *Commercial Building Energy Consumption and Expenditures*, and *Commercial Building Characteristics*, 1992.

As illustrated in Figure 2, heating, ventilation, and air conditioning (HVAC) and lighting account for almost two-thirds of all electricity use. The remaining one-third is split between office and clinical equipment (20%) and miscellaneous electric plug loads (14%).

The energy requirements for individual medical clinics and offices depend on a number of factors, including the type and size of the building, construction techniques and materials used, climate, number of offices and outpatient rooms, number and size of public spaces, patient capacity, local codes, staff requirements, and the nature of any special services provided by the facility. For comparable facilities, heating loads are higher the further north the facility is located; cooling loads typically increase as the number of floors in a facility increases.

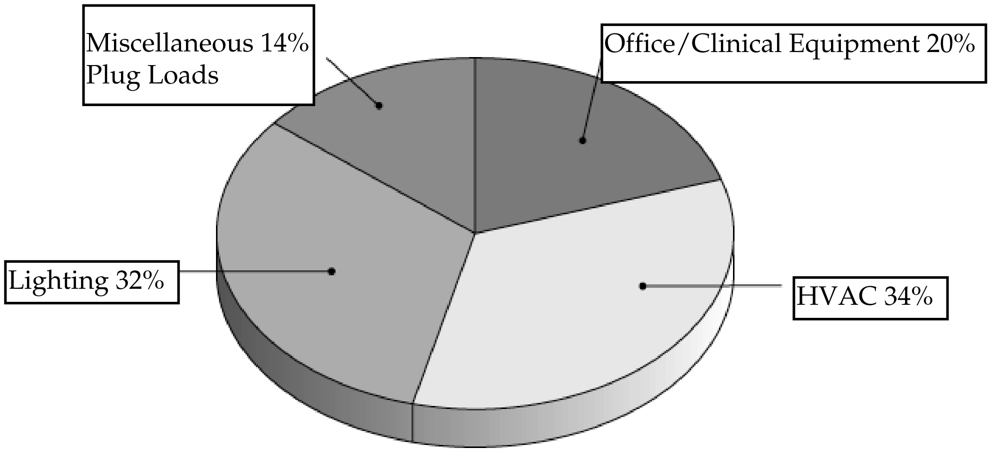


Figure 2
Primary Uses of Electricity in Medical Clinics

2

BUSINESS CHALLENGES AND NEEDS

The biggest challenge for medical clinics today is to maintain high-quality patient care in the face of rising costs and a trend toward managed competition. Adding to the general cost of doing business are environmental, health, and safety regulations established to prevent the spread of infectious disease.

Rising Costs and Increasing Competition

A number of factors contribute to the rising cost to medical clinics of providing healthcare. These include the use of increasingly sophisticated technologies, the growing variety and frequency of treatments, and the heightened need for medical malpractice insurance. In addition, the rise in infectious diseases such as AIDS and hepatitis has prompted implementation of stringent environmental, health, and safety regulations regarding the handling and disposal of potentially infectious medical waste.

In an attempt to prevent the spread of infectious diseases to their patients and employees, and to ensure compliance with health and safety regulations, employees tend to err on the side of caution when deciding whether or not an item should be considered potentially infectious. This cautious attitude, however, has increased the amount of—and therefore the cost of—disposable supplies used each year. The resurgence of drug-resistant airborne diseases such as tuberculosis have also sparked the need for technologies to combat their spread. Finding ways to balance rising costs with health, safety, and regulatory compliance, all while providing high-quality healthcare, is the most significant challenge facing medical clinics today.

Further providing impetus to medical clinics' quest to control costs is the recent trend toward increased competition within the industry. The rise in the cost of healthcare to the consumer—passed on by healthcare providers—has led to a push for organizational changes in the healthcare system. One concept, known as "managed competition," is designed to promote competition in the industry; it rewards healthcare providers and insurers for efficient healthcare delivery in terms of cost, access, quality, and consumer satisfaction. Critics of managed competition have expressed concern about the quality of care provided under such a system. Proponents maintain that managed competition may have a positive effect on the quality of care when compared to the traditional fee-for-service/insurance system. Either way, most healthcare practitioners believe that increased competition in the industry is inevitable.

Need

Reduce Operating Costs

If clinics and clinicians are going to succeed in a more competitive environment, they must find innovative ways to reduce operating costs while still maintaining high-quality patient care. Reduced operating costs can allow them to not only offer cost-competitive services to patients but to improve their bottom line.

Energy-saving technologies represent one way to cut operating costs; these are likely to be of interest only to clinics or clinicians who own and operate their facility. In this situation, any cost savings would return to the owner(s) in the form of reduced operating costs.

Typically, however, clinics and clinicians lease space in a building and the building owner pays the utility bills. In this case, the clinic or clinicians are not likely to be interested in investments to improve energy efficiency because they would not realize a direct benefit from the savings. In some cases, all or a portion of a building's tenants are individually metered or pay a share of the building's utility bills. In this situation, a clinic/clinician tenant may be interested in energy improvements, but the owner would have no incentive to incur any improvement costs because the savings would accrue to the tenant.

Technology Solutions

Technologies that can help clinics reduce operating costs include energy-efficient HVAC systems, indoor lighting, and office equipment. These technologies can cut costs by reducing the amount of electricity consumed for these end uses. Separately, a variety of commercialized and emerging electrotechnologies offer clinics new options in disposal of infectious waste. Depending on the cost of a clinic's current method of disposal, these electrotechnologies may offer a cost savings. The currently available technologies include infrared sterilization and a variety of systems specifically suited to processing low volumes of waste. Microwave disinfection and resistance pyrolysis are two emerging waste management electrotechnologies.

See pages 3-4, 3-6, 3-7, 3-12, 3-13

Environmental, Health, and Safety Regulations

Environmental, health, and safety regulations create significant challenges for healthcare facilities. The primary regulatory issue for small medical clinics and offices is adhering to the prescribed methods for handling and disposing of infectious waste. A secondary but increasingly important challenge is implementation of procedures to prevent the spread of airborne diseases such as tuberculosis.

Need

Safe Disposal of Infectious Waste

Medical clinics, like hospitals and any other facility providing direct medical services to the public, generate infectious waste—materials exposed to potentially contaminated blood or saliva. Handling and disposal of this waste is governed by state regulations and two sets of federal regulations—the Occupational Safety and Health Act (OSHA) and Clean Air Act Amendments (CAAA).

State Regulations

Extreme mismanagement of medical waste during the summer of 1988 resulted in syringes and other waste washing up on beaches of the East Coast. These incidents received high media exposure and sparked public concern and a flurry of legislative and regulatory activity at both the federal and state levels. The federal legislation amounted to a voluntary two-year medical waste tracking program that expired in 1991. At the state level, the incidents prompted more than 40 states to develop regulations for the management of infectious waste.

While the definition of infectious or "regulated medical waste" varies from state to state, states typically prohibit municipal landfills from accepting untreated infectious waste; instead, all infectious waste must be treated and disposed of at a licensed facility. Some states have also initiated "cradle-to-grave" waste management guidelines, similar to those that already exist for hazardous waste. Future reauthorization of the Resource Conservation and Recovery Act, the law governing the handling, transportation, and disposal of solid and hazardous waste, however, could require the Environmental Protection Agency (EPA) to promulgate mandatory federal guidelines for medical waste.

Occupational Safety and Health Act

The majority of the relevant OSHA regulations—including those requiring the disposal of gloves, masks, needles, and other sharps exposed to blood and/or saliva—are reiterations of guidelines previously issued by other organizations such as the EPA and Centers for Disease Control. The OSHA regulations, however, add to the guidelines by explicitly requiring health and safety training for all medical staff working with medical waste, so that they are made aware of the potential effects of exposure to the waste.

In 1992, the Occupational Safety and Health Administration extended OSHA medical waste regulations from hospitals to medical clinics and offices of doctors and dentists. These regulations, designed to protect workers from exposure to such diseases as hepatitis and AIDS, dramatically increased the number of regulations that such facilities must comply with and the amount of infectious waste that they generate. Although OSHA rules apply only to materials that become potentially infectious through exposure to blood or other bodily fluids, doctors and clinic staff must make case-by-case decisions about the level of exposure. Since the fines for violating OSHA regulations can be high—ranging from $1000 to $70,000—healthcare practitioners are extremely cautious, preferring to err on the side of safety. Consequently, they now manage and dispose of large volumes of materials as potentially infectious waste. Furthermore, in this environment of caution, clinics and practitioners are increasingly preferring disposable medical supplies over conventional reusable supplies. As a result, as reported in the *Washington Post,* before the new OSHA rule, a typical two-partner medical practice accumulated a single bag of potentially infectious waste every three months. Now the same practice accumulates nearly one bag every week.

Although OSHA regulations have increased the volume of waste considered potentially infectious and requiring specific disposal, the cost of disposal may be so minimal that it is not of concern to a clinic. The average disposal cost for a medical clinic is just $300 per year (however, across the country, the cost of disposal varies widely by location). The major issue is the cost of purchasing disposable medical supplies, which continually need replenishing. According to the *Washington Post* article, the cost of supplies for many small practices has doubled.

Clean Air Act Amendments

In addition to OSHA and state regulations governing infectious waste, medical clinics may also be affected by the CAAA of 1990. The CAAA required the EPA to develop performance standards for both new and existing incinerators of medical waste. Any medical clinic that sends infectious waste to an off-site incinerator for disposal may be indirectly affected by the rules that tightened emissions standards for medical waste incinerators.

The EPA's new regulations took effect in April 1996 and are intended to reduce the public health risk from nine pollutants emitted by medical waste incinerators—lead, cadmium, dioxin, mercury, sulfur dioxide, nitrogen dioxide, hydrogen chloride, carbon monoxide, and particulates—by 88,000 tons, or 95%. Existing facilities have 2–5 years to comply, while new facilities will have 6 months. Older incinerators may shut down rather than undertake the large capital investment in air pollution control equipment that would be required. Those that remain in operation are likely to pass their costs on to their customers in the form of increased infectious waste disposal prices.

Technology Solutions

Depending on the cost of its current infectious waste disposal method, a medical clinic could potentially benefit from utilizing infrared sterilization or low-volume waste treatment technology to disinfect and dispose of infectious waste. Two additional emerging electrotechnologies, microwave disinfection and resistance pyrolysis, currently used by hospitals, may eventually be available in smaller sizes suitable for use in medical clinics or by groups of medical offices. In addition to potentially reducing the cost of infectious waste disposal, on-site treatment technologies can also reduce the liability associated with having waste disposed of off-site.

See pages 3-12, 3-13

Need

Protect Patient and Employee Health and Safety

Indoor air quality has become an important business issue as clinic owners, operators, and designers begin to understand the influence of this environmental factor on patient and employee health and safety, and on employee productivity. Many newer buildings, those designed and constructed since the 1970s, are tightly sealed to improve energy efficiency. HVAC systems in these buildings take in lower amounts of fresh air in an effort to minimize space-conditioning energy use. As air is recirculated by an HVAC system, the system can serve as a conduit for bacteria, viruses, and mold spores that can readily multiply in the system's warm, humid atmosphere, potentially causing allergic reactions and illness among the building occupants. The problem is so prevalent, it has been termed "sick building syndrome." As many as 30% of public buildings are believed to have problems with indoor air quality. While comfortable temperature, humidity, and lighting levels are relatively easy to achieve and control, maintaining healthy indoor air quality remains a challenge.

Poor indoor air quality can result in discomfort and ill health, leading to higher employee absenteeism, lower morale, and decreased productivity. Airborne diseases such as tuberculosis are also on the rise and can be transmitted through the air or ventilating systems in such buildings as clinics, hospitals, offices, hotels, and homeless shelters—anywhere people congregate.

Technology Solutions

Air sanitation technologies, such as those utilizing ultraviolet light, sterilize the air by killing bacteria and other microorganisms (such as mold spores, known allergens), thereby improving indoor air quality and ensuring that airborne diseases are not transmitted to patients or employees in the facility.

See page 3-4

3

TECHNOLOGY SOLUTIONS

This section describes each of the technology solutions identified in the previous section. Each technology is summarized, linked by end-use application to a business need, and categorized as an “electrotechnology” or “efficiency technology.” Electrotechnologies are selected new or alternative electric equipment options. In many medical clinic settings, the electrotechnologies can increase operating efficiency, expand waste disposal options, improve employee and patient health and safety, and may couple increased energy costs with an overall decrease in operating costs. Efficiency technologies, in contrast, primarily offer opportunities to decrease energy use.

“Emerging electrotechnologies” are also discussed; these are electrotechnologies that are not currently in use in the industry but that have the potential to address an identified business challenge at some point in the future. Each technology is more completely described in Section 4, Electrotechnology Profiles. Vendors of these electrotechnologies, sources for information on efficiency technologies, and trade associations are listed in Section 5, Resources.

Also identified are “partnering opportunities”—opportunities for a utility to conduct energy-related educational or other activities that might enhance medical clinic facilities or operations. For example, medical clinics use many instruments that are highly sensitive to power quality; utilities can provide information or services that could help resolve problems related to power quality.

The technologies are grouped and discussed according to their end use, beginning with “Heating, Ventilation, and Air Conditioning,” the end use that consumes the greatest percentage of total medical clinic electricity use. Table 3 summarizes these end uses and solutions.

Table 3
Technology Solutions to Medical Clinic Needs*

			Business Needs		
End Use	**Solution Type**	**Technology Type**	**Reduce Operating Costs**	**Safely Dispose of Infectious Waste**	**Protect Patient and Employee Health and Safety**
HVAC	Efficiency Technology	Energy-Efficient HVAC Systems	■		
HVAC	Electrotechnology	Ultraviolet Disinfection of Air			■
Lighting	Efficiency Technology	Energy-Efficient Indoor Lighting	■		
Lighting	Electrotechnology	Energy-Efficient Outdoor Lighting	■		■
Office, Clinical, and Miscellaneous Equipment	Partnering Opportunity	Power Quality Assistance and Services	■		
Office, Clinical, and Miscellaneous Equipment	Efficiency Technology	Energy-Efficient Office Equipment	■		
Medical Waste Management	Electrotechnology	Infrared Sterilization	■	■	
Medical Waste Management	Electrotechnology	Low-Volume Infectious Waste Management	■	■	
Medical Waste Management	Emerging Electrotechnology	Microwave Disinfection	■	■	
Medical Waste Management	Emerging Electrotechnology	Resistance Pyrolysis	■	■	

*Although not specifically addressed, many of the business needs and technology solutions discussed in this Guide are also applicable to nursing and personal care facilities (SIC 805), hospitals (SIC 806), medical and dental laboratories (SIC 807), home healthcare services (SIC 808), and miscellaneous healthcare services not elsewhere classified (SIC 809).

Heating, Ventilation, and Air Conditioning

HVAC systems—which account for 34% of the electricity consumption in medical clinics—are necessary to ensure patient and employee comfort, proper functioning of medical equipment, and a sufficiently sterile environment. Medical clinics have a variety of service needs that influence HVAC design criteria, albeit the needs of clinics are less extreme than those of hospitals. An additional concern for clinics is the increasing occurrence of contagious airborne diseases such as tuberculosis. The air handling systems in today’s buildings often provide effective conduits for the spread of such diseases.

Medical clinics and offices that support only diagnostic services have HVAC loads similar to those of office buildings: people, lights, ventilation, and normal building envelope heat gains and losses. HVAC systems in these settings must also have the ability to meet ventilation rate regulations and high air-exchange rates; the ability to provide space-conditioning control in each room; and the flexibility to meet the specific indoor air quality requirements of examining rooms, waiting rooms, laboratories, and offices simultaneously without cross-contamination of zones.

Medical clinics that support surgical operations have more stringent system reliability standards and environmental requirements. These facilities need essentially the same special design attention given to surgical rooms in a full-care hospital. The two critical factors are lighting and people-density, both of which tend to be high in operating rooms and thereby mandate year-round cooling. Surgical suites often have their own dedicated HVAC unit, even in large facilities with central-station chilled water systems.

Among other things, separating operating suite HVAC equipment from a medical clinic’s primary HVAC system decreases the required capacity of the emergency power equipment. Since only essential facility needs and critical areas of a clinic are supported during emergencies, a separate suite-only HVAC system would minimize the installation and maintenance costs of the emergency support system.

If a medical clinic or office has operating suites with dedicated HVAC units, additional HVAC requirements may include

- Maintaining air pressure differences between rooms. Positive or negative pressure is achieved by controlling the amount of exhaust air relative to the inlet ventilation air and interlocking the two systems. Air recirculation between rooms must be avoided.
- Using high-efficiency air filters capable of capturing 80–99.9% of airborne particulate as small as 0.3 millimeters in certain critical areas, such as bone marrow transplant operating rooms.

- Meeting high ventilation and exhaust-air standards. Typical ventilation rates are 15 room air changes per hour within a facility and 5 outside air changes per hour with respect to the building envelope.
- Installing noninductive ceiling diffusers with low side-wall return grilles.

The need to control room pressure precludes the use of variable-air-volume systems except in noncritical areas such as waiting rooms. Facilities large enough for central chilled water systems would use constant-volume central-station air handlers and individual room fan-coil units.

Most medical clinics and offices, however, are too small for central systems. Rather, they are appropriate for any of the packaged, self-contained, or split systems available. Similar to large office buildings, some clinics have interior zones that are basically unaffected by sun position (i.e., insolation) or ambient temperatures. In these clinics, interior and exterior zones should be serviced by independent air-delivery and control systems, based on each area's specific needs.

Clinics have moderate cooling loads, typically 425 square feet per ton, compared to the much higher hospital load of 280 square feet per ton. Recent studies demonstrate the feasibility and advantages of allowing the operating suite staff to choose a temperature level that is comfortable. It should, however, be in the range of 68–76°F with relative humidity of 50–60%.

Efficiency Technology Solution
Energy-Efficient HVAC Systems

Unlike full-care medical centers and hospitals, medical clinics and offices operate only 8 to 12 hours per day. Therefore, these facilities can take advantage of office-building-type energy saving opportunities, such as night setback, ramped temperature pulldown for morning startup, and thermal energy storage for air conditioning. Exhaust-to-inlet air heat exchange is also a possibility, provided that cross-contamination can be prevented. In addition, larger medical facilities using a lot of hot water can potentially benefit from heat pump or heat recovery water heating.

Electrotechnology Solution
Ultraviolet Disinfection of Air

An issue of increasing importance for medical clinics is disinfection of indoor air. Airborne diseases such as tuberculosis are on the rise and can be transmitted through the air or ventilating systems in clinics, hospitals, offices, hotels, and homeless shelters—any place where people congregate. Although filters and proper ventilation are an effective means of removing dust, pollen, other airborne particles, and some microorganisms, they are not able to capture some very small bacteria and viruses, making additional safeguards desirable. Air sanitation units utilizing ultraviolet (UV) light kill all types of microorganisms, sterilizing the air and helping to ensure against transmission of disease.

UV light kills microorganisms by penetrating their cell walls and breaking down their DNA photochemically. Shortwave UV-C light (<280 nanometers) is generated by UV lamps, which are similar to fluorescent tube lamps except that the tubes are made of quartz glass and the inside of the tube is not coated with phosphor. The fixtures are easy to install and can be ceiling- or wall-mounted or mounted within ventilation ducts. The within-duct fixtures are adaptable to air conditioning systems, combined air heating and cooling systems, and exhaust systems.

UV lamps were commonly used for disinfecting hospitals, bakeries, kitchens, and pharmaceutical laboratories after World War II. Their use declined throughout the 1960s, however, as higher mechanical ventilation rates reduced their effectiveness, and the availability of new drugs reduced concern about airborne diseases. Today, airborne diseases are on the rise, and the technical problems associated with higher ventilation rates have been overcome. The National Tuberculosis Coalition, a joint effort of EPRI's Healthcare Initiative, Consolidated Edison of New York, Harvard University Medical School, and other utilities and health organizations, is conducting research to test the effectiveness of UV germicidal light in fighting the new, drug-resistant strains of tuberculosis. They are currently beginning a five-year study. Data collected in the study will help promote the use of UV disinfection of air in healthcare facilities and other types of public buildings throughout the country.

Lighting

Lighting accounts for approximately 32% of the electricity used in a medical clinic. Lighting plays important roles in establishing ambiance and supporting the quality of services provided in a clinic. Proper lighting—a level of lighting that provides brightness without glare—is not only essential to proper diagnosis and treatment, but also underpins employee health, morale, and productivity.

Three types of lighting systems are generally used in medical clinics; fluorescent tubes with magnetic ballasts are the dominant system. Typically, fluorescent lamps illuminate the majority of a facility. Fluorescent fixtures come in a variety of shapes and sizes. Some of the most common are 4-foot-long tubes used in two-, three-, or four-tube fixtures. The basic components of the fluorescent lighting system are fixture, reflector, switch, tubes, ballast, and lenses. Compact fluorescent bulbs are becoming more popular but are still only used in 9% of medical clinics.

The second most common lighting source is incandescent lighting. These fixtures are relatively inexpensive and easy to install, but are the least efficient lighting source available. Due to their inefficiency, medical clinics commonly limit their use to waiting areas, hallways, and exits. The most common application is a ceiling-mounted down light, also referred to as a recessed can.

High intensity discharge (HID) lamps are another type of lighting used in medical clinics. The HID family includes mercury vapor, metal halide, and high-pressure sodium lamps. Although these lamps are most commonly used in parking lots and driveways, they can be used in atriums and other large open areas. All of the HID lamps have significantly longer lives than incandescent lamps and many fluorescent lamps. To date, HID lamps are used by 8% of all medical clinic facilities.

Efficiency Technology Solution
Energy-Efficient Indoor Lighting

The most efficient form of fluorescent lighting available today is the T-8 fluorescent lamp with an electronic ballast. Conversion from a magnetic (T-12, 40-watt) ballast to an electronic (T-8, 32-watt) ballast can be accomplished by either retrofitting the existing fixture or installing a new fixture designed for T-8 lamps, at a cost of roughly $50 and $100 respectively. Ceiling-mounted incandescent lamps can be successfully replaced with compact fluorescent lamps when the ceiling height is less than 12 feet. Retrofitting incandescent lamps in waiting rooms is another simple option.

Electrotechnology Solution
Energy-Efficient Outdoor Lighting

Outdoor lighting is sometimes part of a medical clinic's energy bill. Existing applications include incandescent lights on the building's sign, fluorescent lighting in a parking garage, and mercury vapor lights in a parking lot, walkways, or driveway. While these lighting systems do not necessarily represent a significant portion of the energy bill, they can be cost-effectively upgraded to more energy-efficient systems. In addition, other important benefits can be realized by increasing outdoor lighting levels. Better lighting can reduce the potential for crime, increase patient and employee safety, and increase the visibility of the building exterior and grounds.

Office, Clinical, and Miscellaneous Equipment

Electricity has had an enormous impact on the healthcare industry because its simplicity and versatility has enabled development of highly sophisticated diagnostic and surgical tools and procedures. Considered together, the electrical loads of medical office and clinic equipment (20%) and miscellaneous equipment (14%) represent over one-third of the electricity consumed in a medical clinic.

Power Quality

The increasing use of high-tech electrical equipment in modern healthcare is raising power quality concerns. Ultra-sensitive microprocessors have reduced the tolerance of medical devices to voltage sags and power interruptions of even a few seconds duration. The functioning of many devices also can be disturbed by the power usage of nearby devices—a problem known as electromagnetic incompatibility. These types of power quality problems can cause equipment to fail or can give false readings, scramble computer data, blur X-ray images, and even destroy equipment. Although such incidents rarely put a patient in danger, they can delay patient care and increase costs to the facility and, ultimately, to the patient.

Power quality-related incidents are becoming more prevalent because of the growth of “nonlinear” loads, loads drawing electricity in an irregular waveform. These loads consist of electronic equipment that is both sensitive to common electrical disturbances and disruptive itself, introducing disturbances back onto the power line, potentially affecting other equipment on the line within the building.

Since many medical clinics and offices have sophisticated electronic equipment, such as computerized axial tomography (CAT) scanners, magnetic resonance imaging (MRI) machines, heart catheters, linear accelerators, X-ray stations, and computer systems, they are particularly vulnerable to power quality problems. A high concentration of nonlinear loads also increases the likelihood that these loads are interrupted by other equipment, such as adjustable speed drives employed in HVAC systems.

Partnering Opportunity
Power Quality Assistance and Services

While larger healthcare establishments may have their own power quality experts on staff to determine the best solution for a given problem, most small clinics and offices do not. Many utilities are in a position to provide power quality information and services to clinics and clinicians, including advice on investigating and solving power quality problems or obtaining power-conditioning equipment and emergency power supplies. The EPRI Healthcare Initiative is helping utilities work with healthcare providers to improve power quality and reliability—and thereby avoid delays in patient care, minimize damage to sensitive medical equipment, and save money.

Office Equipment

In addition to electronic medical equipment, medical clinics also use office equipment, such as personal computers, printers, copiers, and facsimile machines, in their operations. This type of equipment represents a growing use of electricity. Not only does office equipment consume electricity, it also generates waste heat that must be offset by HVAC systems.

Efficiency Technology Solution Energy-Efficient Office Equipment

Office equipment energy consumption can be reduced significantly by purchasing new energy-efficient equipment and operating existing equipment in an energy-efficient manner. When purchasing new office equipment, companies typically consider price, speed, reliability, and quality, but rarely consider energy efficiency or the waste heat generated by the equipment. In addition to the direct energy savings of energy-efficient office equipment, there are indirect benefits including reduced demand on building electrical wiring and increased comfort due to reduced fan noise and waste heat generation. The use of energy-saving laptop computers also increases employee flexibility.

Medical Waste Management

Although the services provided by individual medical clinics and offices can vary significantly, they have one characteristic in common: the generation of both infectious and noninfectious medical waste. Medical waste refers to waste generated at hospitals, clinics, doctor and dentist offices, labs, and research facilities. While the definition of "infectious waste" varies from state to state, it is generally defined as "waste capable of producing infectious disease." In some states, anything that comes into contact with a patient—including bedding, drapes, and disposable items such as tongue depressors and thermometer covers—are considered infectious; other states are less conservative.

Although federal regulations governing the disposal of infectious waste do not currently exist, the EPA lists six categories of infectious waste:

- Cultures and stocks of infectious agents and associated biologicals
- Pathological wastes, including those from surgery and autopsy
- Human blood and blood products
- Used sharps (needles, syringes, scalpels)
- Isolation waste (waste from patients isolated with highly communicable diseases)
- Contaminated animal carcasses from medical research

While accurate data are not available, it is estimated that infectious waste makes up about 15% of total medical waste. Yet, because of lack of agreement on the definition of "infectious waste," some estimates put the level of infectious waste as low as 10% (350,000 tons per year), while other estimates are as high as 25% (800,000 tons annually). On average, nonhospital medical facilities produce 1000 pounds of infectious waste per month (a single doctor's office can produce 50 pounds or less per month).

Most states require separation and treatment of infectious waste before disposal. Each medical facility should have a protocol for segregating infectious and noninfectious waste, otherwise all waste should be treated as infectious waste. Identification of waste requiring treatment is usually done on-site, by trained medical staff who know the point of generation, whether the waste is infectious or has hazardous constituents, and are cognizant of additional aesthetic considerations important to the particular facility. Once segregation is accomplished and infectious waste is routed for treatment, the remaining noninfectious waste can be disposed of as municipal solid waste, in a landfill or resource recovery facility, at a lower cost and without treatment.

Medical clinics and offices today have a wide range of options available for treating infectious medical waste. These options include process changes, an assortment of disposal methods, and a variety of treatment technologies—conventional, new, and emerging.

Process Changes

The quantity of infectious waste generated by a medical clinic or office depends on accepted clinic or office procedure. To reduce the volume, many disposable products that quickly expand the volume of infectious waste (e.g., disposable drapes, gowns, and lab coats) could be replaced by reusable ones. Returning to reliance on reusable products is an option under consideration by some facilities. One drawback is that the reusable products still must be treated as infectious and either washed on-site or at a commercial laundry equipped to handle potential contaminants. Such laundries, however, are not easy to find, and often the clinics and offices that choose this route are having to install their own washers and dryers.

Disposal Methods

The options for disposal of infectious or "regulated medical waste" include contracting out transportation and disposal, incinerating all or part of the waste on-site, arranging for incineration at another facility, and autoclaving or performing other on-site sterilization (treatment) and contracting for disposal at a landfill. The choice of disposal option depends largely on facility needs, costs, state or local regulatory requirements, and the feasibility of on-site versus off-site treatment.

In contrast to hospitals—the majority of which use on-site incineration—most medical clinics and offices rely on a third party for their medical waste disposal. The third party can be a municipality, a local hospital, or a private company. Associated costs vary significantly, ranging from $0.13–$0.30 per pound, depending on a facility's location and the chosen disposal method. For small medical clinics and offices, such off-site treatment may be the most cost-effective option, although the clinic or office needs to take precautions in packaging and transport, and must ensure the waste is handled properly at the off-site facility.

The advantage of on-site treatment is that it can minimize both the risk and liability of inadvertent mixing of infectious with noninfectious waste destined for a municipal landfill, or improper disposal into the public arena. Unfortunately, the processes currently available for on-site treatment are oversized for medical clinics and offices, as they are generally sized to process roughly 25 tons per day. The smallest units are designed to process 1–4 tons during a 6- to 14-hour day.

Treatment Technologies

While the majority of methods for on-site treatment of infectious waste are too large for most medical offices and clinics, new, more appropriate technologies are becoming available. The market for technologies and strategies to better manage medical waste is expected to grow at a compound annual rate of 7.2%, to $1.3 billion by 1999—up from $912.4 million in 1994 according to a report by FIND/SVP ("The Medical Waste Management Market"). The primary factors driving this growth include proposed EPA legislation that will force the closure of many older infectious waste incinerators, a decline in landfill capacity in some areas of the country that will exert upward pressure on disposal costs, tougher environmental regulations that will also increase the costs of landfilling, and increased public sensitivity to public health issues such as AIDS.

Conventional Treatment Technologies

Disinfection and/or sterilization are the goals in treating infectious waste. Both processes render the waste harmless via the destruction of most or all of the microorganisms in the waste. The type of infectious waste that must be treated is a consideration when selecting among the treatment techniques. In general, each type of infectious waste has one or more recommended treatments (see Table 4).

Steam Sterilization

Steam sterilization—autoclaving—is the most common form of sterilization used in the healthcare industry today. It involves treating wastes in an enclosed vessel or autoclave. First, all air is removed from the vessel, since residual air in the chamber can prevent effective sterilization. Then the vessel is filled with steam at sufficiently high temperatures to kill all pathogens. Dry (fully saturated) steam is preferred over wet steam, as the degree to which the steam is saturated can influence the effectiveness of the process.

Table 4
Recommended Treatment Techniques for Infectious Waste

Type of Infectious Waste	Steam Sterilization	Incineration	Thermal Inactivation	Chemical Disinfection	Other
Isolation Waste	■	■			
Cultures and Stocks	■	■	■	■	
Human Blood	■	■		■	■[a]
Pathological Wastes	■[b]	■			■[c]
Contaminated Sharps	■	■			
Contaminated Animal Carcasses	■[b]	■			

a - Discharge to a municipal sewer system if secondary treatment is available.

b - For aesthetic reasons, follow with incineration or grinding and sewer disposal in accordance with state or local regulations.

c - Burial or cremation by a mortician.

Source: Adapted from *EPA Guide for Infectious Waste Management,* May 1986.

Incineration

Incineration is the combustion of waste to form ash, noncombustible residues, and off-gases, with the elimination of pathogens, and is the most common method of disinfecting and eliminating infectious waste, reducing both the liability and disposal costs associated with the waste. Incineration reduces the volume of waste 90–95% and renders it unrecognizable. A typical incinerator consists of a primary combustion chamber, a secondary combustion chamber, air pollution control devices (scrubbers and baghouses), and an ash collection system. Infectious waste must be exposed to sufficiently high temperatures for an adequate period of time to ensure destruction of all pathogenic organisms. Many states specify minimum operating temperatures and residence time for incinerators.

State-of-the-art incinerators are able to meet and exceed the current stringent air pollution control requirements. Many incinerators, however, were designed in the 1970s and are not suitable for handling the higher percentage of chlorinated plastics in today’s medical waste. The smoke by-product of these compounds, when burned in a conventional incinerator, may carry infectious particulates, dioxin, and hydrochloric acids. In addition, the release of chlorine content during combustion can result in formation of hydrochloric acid, a substance that can be corrosive to an incinerator. As a result, the EPA is requiring an upgrade of the air pollution control equipment on these older incinerators. The capital investment required may be too large for some incinerator operators, who may instead decide to shut down their facilities. Either way, medical facilities currently using this disposal method should expect costs to increase for infectious waste incineration.

Thermal Inactivation

Thermal inactivation is also known as dry heat sterilization. Similar to steam sterilization (minus the steam in the chamber), this process renders infectious waste sterile by exposure to heat. It tends to be less effective than steam sterilization, however, because it lacks the additional penetration benefits provided by dry (fully saturated) steam. The infectious waste is heated in an electric oven at approximately 320°F for 2 to 4 hours.

Chemical Disinfection

Infectious waste can be disinfected by the addition of chemicals such as hydrogen peroxide, acids, alcohols, quaternary ammonium compounds, or ketones. While used extensively for disinfecting utensils, surfaces, and medical supplies, the process has very limited application for the treatment of other types of infectious waste.

Gas/Vapor Sterilization

Gas or vapor sterilization is primarily used for the sterilization of surgical instruments, although there have been some applications with other types of infectious waste. In this process, the instruments are exposed to gaseous or vaporized chemicals—most often ethylene oxide and formaldehyde—in a sealed chamber. Unfortunately, both of the active chemicals are probable carcinogens, making it likely that this process will be used less and less.

New and Emerging Electrotechnologies

Many electric devices and processes have contributed significantly to both the delivery of high-quality healthcare and the reduction of regulatory burdens within the industry. New and emerging electrotechnologies that show promise as alternatives to autoclaving and incineration include infrared sterilization, four methods for treating low volumes of waste, microwave disinfection, and resistance pyrolysis. These technologies are more environmentally and economically acceptable.

Electrotechnology Solution
Infrared Sterilization

Infrared (IR) sterilization uses far-infrared rays to treat regulated infectious waste quickly and effectively; the rays are focused on and absorbed by the “target” wastes.

The direct heating process—which transfers heat directly to the waste load instead of to the air—is superior to convection heating since "cold spots," areas where microorganisms can survive, are eliminated. The infectious waste volume is reduced by 90%, and the sterilized residue is suitable for municipal landfill disposal. No chemicals, steam, or effluent are generated in the process. Currently, this technology is appropriate only for medical clinics and laboratories generating 50,000–75,000 pounds of medical waste per year.

Electrotechnology Solution
Low-Volume Infectious Waste Treatment

Historically, low-volume infectious waste generators (facilities generating less than 50 pounds of infectious waste per month), such as small doctor and dentist offices, were forced to contract with waste treatment businesses that would haul away their infectious waste for off-site treatment. Recently, however, a number of alternative technologies have become commercially available that allow these low-volume generators to treat some or all of their infectious waste on-site. These technologies can be grouped into four categories based on the type of treatment process—chemical-mechanical, electro-chemical, resistance sterilization, and thermal-mechanical—and offer the advantages of immediate on-site treatment, reduced waste volume, and reduced disposal costs. System purchase costs range from as little as $795 to as much as $39,500 per unit. Electrical requirements are relatively low, however, ranging from 0.1–2.0 kWh per cycle.

Emerging Electrotechnology Solution
Microwave Disinfection

Microwave disinfection can be used to treat 95% of the infectious waste stream, destroying microorganisms and reducing waste volume and transportation and disposal costs by 80%. The process combines shredding, steam, and microwave energy to render the medical waste disinfected and unrecognizable. The residue can then be landfilled as municipal solid waste. In addition, the system requires little space, no chemicals, no specially trained operators, and yields no combustion by-products. The disadvantage is the system's limited ability to handle anatomical waste (for aesthetic reasons), and bulk chemotherapy and radioactive wastes. Although these systems are suitable for on-site location, the units currently available treat 350–900 pounds per hour—much too large for most clinics and smaller hospitals. A medium-sized unit that can treat as little as 50 pounds of waste per day is also available. Today, only 5–10% of all medical facilities employ the technology, but this figure is projected to increase to 25–30% by 2000 as the technology is embraced by hospitals.

Emerging Electrotechnology Solution
Resistance Pyrolysis

Resistance pyrolysis combines pyrolysis and high-temperature oxidation to eliminate infectious waste. Pyrolysis decomposes waste in the absence of oxygen, producing gases, liquids, and solids. Oxidation then destroys all the remaining organic compounds. This technology renders infectious waste unrecognizable and sterile by transforming the waste into a fine, inert ash that represents only 1–2% of the original waste volume. This ash can be disposed of as municipal solid waste, reducing final disposal costs. Electricity is the only input, and the process emits only carbon dioxide and water vapor. Resistance pyrolysis units are designed to process up to 150 pounds of waste per hour. The units are fully automated and can be installed in modules to handle larger amounts of waste. This technology is considered an “emerging” electrotechnology for the medical clinic industry, however, because it is only available in a continuous unit—popular with hospitals but too large for use by smaller infectious waste generators.

4

ELECTROTECHNOLOGY PROFILES

This section provides profiles of the electrotechnologies identified in Sections 2 and 3. Each profile explains the technology, its advantages and disadvantages, commercial status, and costs. The profiles have been designed as stand-alone descriptions so they can be utilized separately from this guidebook. Turn to Section 5 for a list of equipment vendors that can provide more specific technical details.

Ultraviolet Disinfection of Air

Basic Principle

Properly maintained air filters and ventilation systems can effectively remove dust, pollen, other airborne particles, and some microorganisms from indoor air. However, some microorganisms are so small that even the most efficient filters may be unable to capture them, making additional safeguards desirable.

Bacteria and viruses are most prevalent where people congregate—in medical clinics, hospitals, offices, hotels, and stores. The recirculation of indoor air in these places produces the threat of infection. To prevent airborne diseases such as tuberculosis (TB), many institutions (medical facilities, office buildings, hotels/motels, and shopping centers) are considering the installation of air sanitation units.

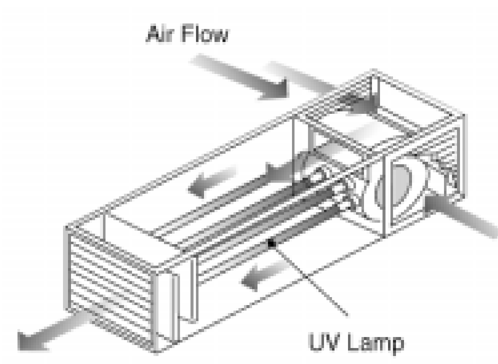
Ultraviolet (UV) germicidal irradiation is a scientifically proven technology that helps prevent the transmission of disease by killing many types of airborne microbes, including those responsible for TB. The UV spectrum lies between X rays and the visible spectrum (180-400 nm). Within this range, UV rays are further divided into longwave UV-A rays (315–400 nm), which are generally used in tanning salons; medium wave UV-B rays (280–315 nm), which are found in sunlight and cause skin cancer and tanning; and shortwave UV-C rays (<280 nm), which are used for disinfection of airborne germs. UV-C rays penetrate the cell walls of microorganisms and cause photochemical breakdown of their DNA; this prevents replication and causes cell death.

System Description

The peak UV absorption efficiency for DNA is 250–260 nm. UV-C lamps are an ideal technology for destruction of airborne germs because their energized cathodes are designed to emit rays at 253.7 nm. These lamps are similar to fluorescent lamps except the tubes are made of quartz glass and their inner surfaces are not coated with phosphor. They can kill microbes that are brought by air currents into their zone of irradiation.

There are two ways of utilizing UV-C lamps: 1) through overhead or upper-air irradiation, in which the lamps are installed in the upper part of a room in the form of simple fixtures or enclosed units; and 2) air duct irradiation, in which the lamps are installed in the ventilation ducts of air handling systems.

- Overhead or Upper-Air Irradiation: The UV-C light fixture or enclosed unit is mounted to either the ceiling or a wall, depending on the height of the room. Overhead installations are best for ceilings that are at least 9 feet high, so the fixtures extend no lower than 7 feet. This is necessary so that room occupants do not bump their heads on the fixtures or look directly into the UV rays. These fixtures should be shielded on the bottom and partially on the side to deflect the UV rays upward or sideways instead of downward. Enclosed, fan-powered UV-C units purify and recirculate air while minimizing the potential for human exposure to UV rays. In this case, the germicidal lamps are completely contained within a stainless steel chamber. Room air is drawn past a particulate filter, forced into a UV-C exposure chamber, and then pushed past baffles and reintroduced into the room. In some units, the exposure chamber is lined with reflective brushed aluminium to boost the effectiveness of the rays.

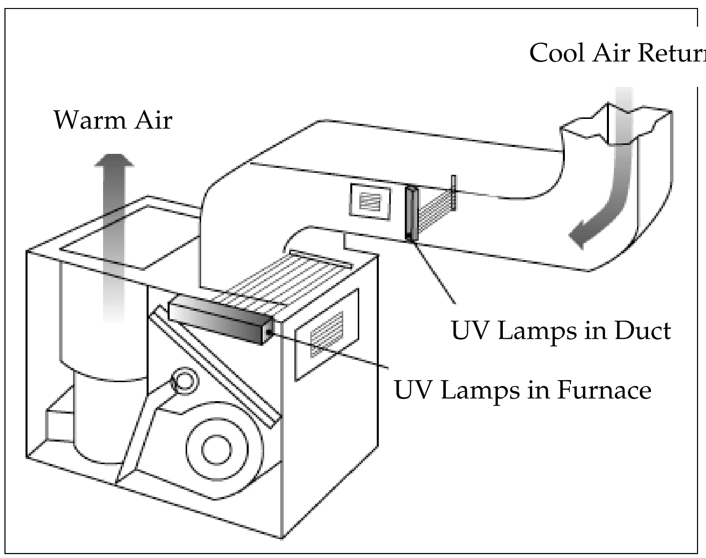


Enclosed UV Unit

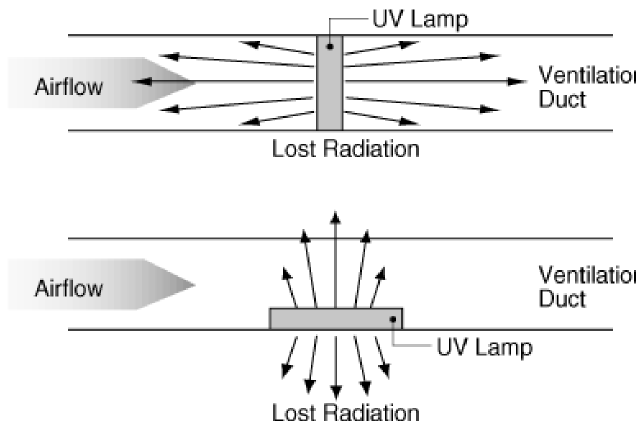
- Air Duct Irradiation: UV-C lamps are installed inside the ventilation ducts of an air handling system. Air handling systems are known conduits for the spread of infectious disease. Until recently UV germicial irradiation could not be applied, because conventional UV-C lamps suffer a drastic loss of output and thus "killing power" when exposed to moving air, and even greater losses when exposed to cold air. New technology has overcome these problems, and UV-C units are available that are effective for temperatures of 32–90°F. Air duct UV-C units can be installed in new or existing air handling systems. Since the effectiveness of the rays increases with the duration of exposure, the lamps should be installed where airflow is slowest, and preferably perpendicular to the airflow so that the light radiates along the length of the air duct. The number of lamps required depends on the volume of air handled by the duct, the height and length of the duct, and the disinfection rate desired.

Advantages

- Effective germicidal treatment of airborne microorganisms
- Easy to install and remove; no building downtime required
- Adaptable to air conditioning systems, combined air heating and cooling systems, and exhaust systems



Air Duct UV Unit



Air Duct Irradiation

- No fumes or secondary contaminants produced
- Relatively low maintenance requirements
- Destroys rather than traps biological contaminants, resulting in less risk for service personnel

Disadvantages

- HVAC ducts may be difficult to access in some existing buildings.
- With upper-air irradiation, caution must be exercised to avoid prolonged direct or indirect exposure to the UV rays.
- Upper-air irradiation can cause plastics in furnishings to deteriorate and wall paint and carpet colors to fade more quickly.

Commercial Status

Current applications of UV disinfection of air include a hospital in Southern California and homeless shelters in Boston, Massachusetts. A recent resurgence of TB and other airborne diseases is causing alarm across the country. Data from 1992 show a 20% increase in TB cases nationwide since 1985; 75% of these cases were among the homeless. Many individuals who contracted TB at homeless shelters are not returning for follow-up treatments, resulting in new, drug-resistant strains of the disease.

In support of UV disinfection of air, a five-year study is being launched by the National Tuberculosis Coalition—a joint effort of EPRI's Healthcare Initiative, Consolidated Edison of New York, Harvard University Medical School, and other utilities and health organizations, to conduct collaborative research, development, and demonstration projects to stop the spread of TB and other airborne diseases. The study will test the effectiveness of UV germicidal light in fighting the new, drug-resistant strains of TB at homeless shelters in six cities (New York City and Birmingham, Alabama, are the known participants to date). Data collected in the study will support promotion of the use of UV disinfection at healthcare facilities, schools, prisons, and public buildings throughout the country.

Ultraviolet Disinfection of Air System Characteristics

Dimensions	Vary with room size and/or duct size and air change requirements; fixtures can be custom built
Power Rating	30-120 watts (1-4 lamps)
Energy Consumption	Approximately 790 kWh annually*
Key Inputs	
Power	Electricity
Other	Dry air source
Key Outputs	
Solid Waste	None
Air Emissions	None
Water Effluent	None
Cost	
Purchase and Installation	Upper-Air Irradiation: $300-$1700/unit Air Duct Irradiation: $300-$700/unit
Replacement Lamp Tubes	$60-$100/tube

*Assuming three 30-watt units used 8760 hours in a 600-square foot area.

Cost and Electrical Requirements

UV-C lamps and units are available nationwide in a variety of models to suit different applications. They are sold through HVAC distributors as well as independent agents. Upper-air irradiation units come in models to accommodate different room sizes and air change requirements. Manufacturers' list prices range from $300–$1700 for enclosed units, depending on the size and number of lamps in the unit. Air duct units are available in many configurations and sizes and can be modified as needed to fit any duct system or air change rate requirement. Manufacturers' list prices range from $300–$700 per unit, depending on the size and number of lamps in the unit. Replacement lamps cost $60–$100 each, depending on wattage and bulb length. For maximum effect, lamp units should run continuously; frequent on/off cycles can shorten bulb life.

Manufacturers also suggest installation of one 30-watt fixture (or two 15-watt fixtures) for every 200 square feet of floor space, or for every seven people in a room—which ever is greater. Therefore, an area with a capacity of 20 people would require three 30-watt units. A facility running these units continuously for one year (8760 hours) would use about 790 kWh in their operation.

EPRI Information

Information on the EPRI Healthcare Initiative is available from the Northeast Regional Community Environmental Center, (800) 424-3774.

Outdoor Lighting

Basic Principle

Many small businesses benefit from enhanced outdoor lighting through reduced potential for crime, increased employee safety, and improved visibility and attractiveness of the facility.

These benefits are obtained for a relatively small operating cost because, in most cases, outdoor lighting does not contribute to a facility's peak electrical demand. This means that the average energy cost for outdoor lighting (in terms of cents/kWh) is typically less than the energy cost of other improvements.

There are three principal methods for using outdoor lighting in small businesses:

1. Signage on the exterior of the building or illuminated signs near the building to generate attention for the building or the small business
2. General lighting in parking lots, driveways, parking garages, and walkways
3. Facade lighting to increase the visibility of the structure and surrounding architectural features and landscaping

Different lighting technologies are typically used for different applications. Existing lighting systems can often be retrofitted or replaced by energy-efficient lighting systems. In addition, existing lighting systems can be supplemented with new lighting systems to increase safety, security, visibility, and name recognition.

Typical Outdoor Lighting Applications

Type of Light	Exterior Signage	Parking Garages	Parking Lots/Driveways	Walkways	Facade and Landscaping
Incandescent	■			■	■
Compact Fluorescent		■		■	■
Fluorescent	■	■		■	■
Metal Halide		■	■	■	■
High-Pressure Sodium			■		
Mercury Vapor			■		

Note: Additional applications are possible for each of the lighting types, but the chart identifies the most efficient applications for each of the light sources. Low-pressure sodium lamps are not normally used in small businesses because of their poor color quality.

System Description

Mercury vapor, high-pressure sodium (HPS), and metal halide lamps are referred to as high-intensity discharge (HID) lamps. Metal halide lamps and HPS lamps provide approximately 100 and 140 lumens per watt, respectively, while mercury vapor lamps provide up to 60 lumens per watt. Mercury vapor lamps emit a bluish green light while HPS lamps emit a yellow orange light. Metal halide lamps emit a predominately white light. Most HID lamps require a spacing-to-mounting height ratio of 1.0–1.9, which means that the spacing is roughly one to two times the pole height.

Each HID lamp requires a specific ballast to drive the lamp; however, some manufacturers offer metal halide and HPS lamps that can be operated by a mercury vapor lamp ballast. This allows easier conversion from inefficient mercury vapor lamps to higher-efficiency metal halide and HPS lamps. HID lamps are available in a variety of wattages from 35–1500. The HID ballast adds approximately 8–15% to the wattage of the lamp.

Fluorescent lamps are also used as outdoor lighting sources for small businesses. Conventional 4-foot and 8-foot tubes are used in many parking garages and covered walkways. Compact fluorescent lamps are also becoming popular as replacements to incandescent lamps in stairways. Newer T-8 lamps and electronic ballasts are approximately 30% more energy-efficient than older 40-watt T-12 lamps with magnetic ballasts.

Incandescent lamps are the least efficient form of outdoor lighting. However, incandescent lamps are still used as spotlights on signs and as floodlights on building facades and landscaping. The short lifetime of incandescent lamps often has a bigger impact on operating costs than does the additional energy use. Common controls used for outdoor lighting systems include time clocks, photocells, and programmable controllers.

Advantages

Well-designed outdoor lighting systems can offer the following advantages:

- Increased perception of comfort and friendliness
- Increased security for customers and employees
- Reduced accidents in driveways, parking areas, and walkways
- Increased visibility for the facility and the small business

Disadvantages

Other than installation and operating costs, there are no overall disadvantages of outdoor lighting. However, specific lamps do have weaknesses:

- HID lamps require 2–7 minutes to warm up before reaching full output.
- Metal halide lamps require up to 15 minutes to cool before restriking.
- Special low-temperature fluorescent lamps are required in cold climates to maintain a relatively constant lumen output below freezing.

Typical Lamp Characteristics for Outdoor Applications

Type of Lamp	Typical Wattages	Initial Lumens/Watt	Avg Rated Life (h)
Incandescent	60-1,500	15-24	750-2,500
Compact Fluorescent	12-35	25-75	8,000-12,000
Fluorescent	20-215	50-100	9,000-20,000
Metal Halide	175-1,500	69-115	10,000-20,000
High-Pressure Sodium	35-1,000	51-140	7,500-24,000
Mercury Vapor	40-1,000	24-60	12,000-24,000

Note: Initial lumens/watt includes ballast losses.

Commercial Status

All of the lamps described above are readily available from a variety of manufacturers. However, mercury vapor and older T-12 fluorescent lamps are being phased out of production.

Gradual improvements have been made in the efficiency of outdoor lighting systems. In addition, color-corrected HPS lamps are available, as well as improved metal halide lamps that contain incandescent or fluorescent lamps that come on if the power is interrupted.

EPRI Information

Additional information on lighting technologies is available from the EPRI Lighting Information Office, (800) 525-8555.

Infrared Sterilization

Basic Principle

The EPA estimates that 1.6 million tons per year of medical waste is produced by all healthcare facilities, of which 0.46 million tons is classified as infectious waste. Approximately 23% of all infectious waste is generated by nonhospital facilities such as clinics and laboratories. Disposing of infectious waste is becoming increasingly difficult due to tougher federal and state emission standards affecting incinerators and shrinking landfill space. For these reasons, medical practitioners and clinics are seeking new technologies that are cost-effective and environmentally safe. One new technology that has emerged is infrared (IR) sterilization.

Infrared sterilization uses IR rays to treat infectious waste quickly and effectively. The rays focus on and are absorbed by the “target” wastes. This target-specific sterilization transfers heat directly to the waste load, instead of to the air. The direct heating process is superior to convection heating since “cold spots”—areas where microorganisms can survive—are prevented. No chemicals, steam, or effluent are generated in the process. The infectious waste is reduced by 90% in volume, and the sterilized residue is suitable for municipal landfill disposal.

System Description

One IR sterilization system is currently available, produced by Medifor-X Corporation® and trademarked as the DISPOZ-ALL 2000®. The system uses recirculating convection heat, conduction, and far IR rays to process infectious wastes. The DISPOZ-ALL 2000® unit has three components: a computer system, a treatment chamber, and a volume reduction chamber. An operator loads infectious waste onto a revolving tray carrier attached to the access door. Upon closing the door and pushing the start button, the computer system takes control. The waste is heated to 425°F for 25 minutes, and is then transferred to the volume reduction chamber automatically via a robotic mechanism. Once this occurs, the treatment chamber is ready for another load. Inside the reduction chamber, the sterilized waste is allowed to cool, then is crushed into an unrecognizable residue suitable for landfill disposal. The system is designed to treat a variety of wastes, including needles, glass tubes, blood, IV bags, and disposable gloves. The unit cannot, however, handle anatomical, radiological, or chemotherapeutic wastes; flammable hydrocarbon materials; and aerosol cans. The DISPOZ-ALL 2000® is appropriate for facilities that generate between 50,000 and 75,000 pounds of regular medical waste per year (24–36 pounds per hour). These facilities are typically larger medical clinics and medical labs.

Advantages

- Compact design: The design allows for complete on-site sterilization of regulated infectious waste with no emissions or effluent.
- Volume reduction: Waste volume is reduced by 90%.
- Automated process: After loading the waste and pushing the start button, the computer control operates the entire process.
- Noiseless and odorless: The system is a closed system; therefore, no emissions are released into the atmosphere.

Infrared Sterilization Unit

Disadvantage

- Disinfection limited to certain infectious waste: The system cannot process anatomical, radiological, or chemotherapeutic wastes; flammable hydrocarbon materials; or aerosol cans.

Commercial Status

The DISPOZ-ALL 2000® is permitted for use in all states except Alabama, Maryland, Ohio, Oregon, Pennsylvania, Rhode Island, and West Virginia. Approval is pending in these states. Currently, four systems are operating in small hospitals.

Cost and Electrical Requirements

The capital cost for the IR sterilization unit is $59,500; a leasing program can be arranged. The operating and maintenance cost of an average 20-lb load is $3.85. The unit can handle up to 40 lb of waste per hour and consumes approximately 0.275 kWh/lb of waste.

Infrared Sterilization System Characteristics

Dimensions	Width: 34.5″ Length: 101″ Height: 78″
Weight	2000 lb
Feed Capacity	40 lb/h
Power Rating	11 kW
Energy Consumption	0.275 kWh/lb
Key Inputs	
Power	Electricity
Other	None
Key Outputs	
Solid Waste	Municipal waste
Air Emissions	None
Water Effluent	None
Cost	
Purchase	$59,500
Operating and Maintenance	$0.19/lb

Low-Volume Infectious Waste Treatment

Basic Principle

According to the U.S. Environmental Protection Agency (EPA), non-hospital healthcare facilities produce approximately 106,600 tons of infectious waste annually in the United States. On average, non-hospital medical facilities produce 1000 pounds of infectious waste per month. Some facilities, such as doctors' offices, dental offices, nursing homes, and funeral homes, produce less than 50 pounds of infectious waste per month. Since these facilities individually generate such low volumes of infectious waste, little attention has been paid to developing treatment technologies for this category of infectious waste generators. Yet these facilities face the same medical waste disposal problems as hospitals, such as liability, potential threat to occupational safety and health, increasingly stringent regulations, and the rising cost of traditional methods of treatment and disposal.

Recently, however, a number of alternative infectious waste treatment technologies have been introduced for low-volume generators. These technologies can be grouped into four categories, based on the type of treatment processes utilized: chemical-mechanical, electro-chemical, resistance sterilization, and thermal-mechanical.

Chemical-Mechanical

This type of process utilizes chemical and mechanical methods to destroy and decontaminate biohazardous waste such as syringes, needles, glassware, laboratory waste, blood and other body fluids, specimens, cultures, and other contaminants. It cannot, however, treat chemotherapeutic and pathology wastes or hazardous chemicals.

In this process, infectious waste is placed into a portable chamber at the point of generation. When the chamber is full, it can be transported to the processor. At this point, a specific dose of decontaminant—a peracetic acid formulation—is added to the waste. The waste is then mechanically ground and chemically decontaminated. At the end of a 10-minute cycle, the liquid by-products—vinegar and hydrogen peroxide—are separated from the solid waste and discharged into the sewer. The solid waste can then be sent to the landfill with the regular municipal solid waste. This system can treat up to 8 pounds of waste per 10-minute cycle.

Electro-Chemical

Like the chemical-mechanical process, this method can decontaminate medical waste including sharps, blood and other body fluids, cultures, dialysis waste, lab waste, disposable gowns, gloves, and masks, but cannot treat chemotherapeutic and pathology wastes or hazardous chemicals.

In this type of system, up to 20 pounds of infectious waste is placed in a removable basket and immersed in a sodium chloride ($NaCl$) and water mixture. Patented electrodes at the bottom of the container liberate chlorine, ozone, and their respective hydroxyl radicals, which decontaminate the waste. This process destroys all pathogens and spores in approximately five minutes, thus rendering the waste safe and legal for disposal in a municipal landfill.

Resistance Sterilization

Heat and time, when combined, are an effective method of sterilization. Laboratory tests show that no microorganism can survive temperatures above 356°F for more than a fraction of a minute. Based on this principle, a resistance sterilization unit has been designed to treat sharps (syringes, needles, and scalpels).

In the resistance sterilization process, infectious sharps are collected in a plastic container near the point of contamination. When full, the container and a temperature-indexed plastic disk are placed in the processor. Thermal energy then melts the container and specially-designed disk, creating a molten liquid that flows through the waste. The plastic disk is certified not to melt below 375°F. The melting of the disk is therefore evidence that temperature and time requirements have been met and serves as a biophysical indication of sterilization. The sterilized material cools into a solid plastic block that can be discarded as municipal solid waste. A resistance sterilization unit can treat 0.7–1.7 quarts of waste every 5 hours, and reduces waste volume by as much as 80%.

Thermal-Mechanical

This treatment system uses heat and mechanical action to render infectious sharps and rigid plastic waste sterile and unrecognizable and therefore suitable for municipal landfill disposal. Two systems are currently available: a small unit that can treat 40 syringes an hour, and a larger unit that can treat up to 16 gallons of sharps and rigid plastic every 105 minutes. In both units, the waste is collected in a specially-designed container at the point of generation. When the container is full, it is fed into a central processor. In the smaller system, the waste is ground and then heated for 30 minutes at 480°F, by transforming it into a non-infectious plug that is approximately 15% of its original volume and about 4 inches in diameter. In the larger unit, the infectious waste is heated at 535°F and converted into a non-infectious block that is approximately 20% of its original volume. An optional grinder can be used to reduce the waste to unrecognizable shavings.

Low-Volume Medical Waste Systems

Technology	Chemical-Mechanical	Electro-Chemical	Thermal-Mechanical	Resistance Sterilization
Dimensions	Width: 45.5″ Depth: 31″ Height: 52″	Diameter: 24″ Height: 48″	Width: 21.5″-37″ Depth: 12.5″-32″ Height: 34″-66″	Diameter: 8.5″ Height: 21″
Estimated Reduction in Waste Volume	80%	0%	80-85%	80%
Feed Capacity	up to 48 lb/h	120 lb/h	Small unit: 40 syringes/h Large unit: 9 gal/h	0.7-1.7 qt/5 h
Energy Consumption	3.7-4.3 kW	2 kWh/cycle	0.1-0.9 kWh/cycle	0.75 kWh/lb of waste
Key Inputs:				
Power	Electricity	Electricity	Electricity	Electricity
Other	Peracetic acid	NaCl	None	Plastic disks
Key Outputs:				
Solid Waste	Non-infectious	Non-infectious	Non-infectious	Non-infectious
Air Emissions	None	None	None	None
Water Effluent	Sewage	None	None	None
Cost				
Purchase	$18,000	$39,500	$5300-$25,000	$795
Operating Cost	less than $1/lb	$0.1/min	minimal	$1.95/disk $5.95/0.7qt container $6.95/1.7qt container

Advantages

- On-site treatment of waste: Reduces liability because regulated medical or infectious waste is processed on-site into non-regulated solid waste.
- Reduces waste volume: All systems except the electro-chemical process reduce the volume of the infectious waste by 75–85%.
- Reduces disposal costs: In most cases, disposal costs are reduced by eliminating licensed haulers, third-party services, and in-office record keeping; instead, the waste goes to the municipal solid waste landfill.
- Immediate waste disposal: Wastes can be disposed of immediately, instead of being stored for weeks or months until a large enough load accumulates for pick-up.

Disadvantage

- Disinfection limited to certain infectious waste: Most systems cannot process anatomical, radiological, or chemotherapeutic wastes.

Commercial Status

All systems are commercially available and specifically designed for on-site sterilization of the small volumes of infectious wastes typically generated at dental or medical offices. Each technology is available from only one manufacturer, however, making price concessions less likely than if multiple vendors offered similar equipment.

Cost and Electrical Requirements

Cost and electrical requirements vary significantly from one technology to another. To estimate the cost of a specific application, the waste composition, the amount of waste to be processed, and the waste disposal method must be known. The accompanying table summarizes the cost and energy requirements for each of the four technologies.

5

RESOURCES

This section contains three lists: 1) equipment suppliers for the electrotechnologies profiled in this guide, by equipment type; 2) EPRI information resources on efficiency technologies; and 3) medical industry associations. Information used to compile these lists was based on a combination of a telephone survey, published reports, directories, buyer's guides, and technical journals. The information was current at the time of publication and is expected to change over time.

Ultraviolet Disinfection of Air

Equipment Suppliers

American Ultraviolet Corp.
212 North Mt. Zion Rd., Lebanon, IN 46052
(317) 483-9514, fax: (317) 483-9525

Atlantic Ultraviolet
375 Marcus Boulevard, Hauppauge, NY 11788
(516) 273-0500, fax: (516) 273-0771

Fuller Ultraviolet Corp.
P.O. Box 667, 9416 Gulfstream Road, Frankfort, IL 60423
(815) 469-3301, fax: (815) 469-1438

Steril-Aire USA, Inc.
11100 E. Artesia Blvd. Suite D, Cerritos, CA 90703
(310) 467-8484, fax: (310) 467-8481

Ultraviolet Systems and Equipment, Inc.
9135 Spring Branch Dr. Suite 202, Houston, TX 77080
(713) 461-7666, fax: (713) 461-7760

UV Technologies
4728 Brayton Terrace S., Palm Harbor, FL 34685
(813) 937-4022, fax: (813) 943-0911

Outdoor Lighting

Equipment Suppliers

Bairnco Corp.
2251 Lucien Way No. 300, Maitland, FL 32751
(407) 875-2222, fax: (407) 875-3398

Bieber Lighting Corp.
970 W. Manchester Blvd., Inglewood, CA 90301
(213) 776-4744, fax: (310) 216-0333

Bulbtronic Inc.
45 Banfi Plaza, Farmingdale, NY 11735
(800) 647-2852, (516) 249-2272, fax: (516) 249-6066

Carlon (Lanson & Sessions Co.)
25701 Science Park Dr., Cleveland, OH 44122
(216) 831-4000, fax: (216) 831-5579

Cooper Lighting Group
400 Busse Rd., Elk Grove Village, IL 60007-2195
(847) 956-8400, fax: (847) 956-1475

Crouse-Hinds Co.
Lighting Production Div., P.O. Box 4999, Syracuse, NY 13221
(315) 477-8185

Doane, L.C., Co.
55 Plains Rd., P.O. Box 975, Essex, CT 06428
(203) 767-8295, fax: (203) 767-1397

Duro-Test Corp.
9 Law Dr., Fairfield, NJ 07004
(201) 808-1800, fax: (201) 808-6622

Federal APD Inc., Federal Signal Corp.
24700 Crestview Court, Farmington Hills, MI 48335
(800) 521-9330, (810) 477-2700, fax: (810) 477-0742

Gardco Lighting
2661 Alvarado St., San Leandro, CA 94577
(510) 357-6900, fax: (510) 357-3088

G.E. Company
3135 Easton Turnpike, Fairfield, CT 06431
(800) 626-2004, fax: (518) 869-2828

Hapco Div. of Kearney-National Inc.
P.O. Box 547-KN, Abingdon, VA 24210
(540) 628-7171, fax: (540) 628-7707

Litetronics International
4101 W. 123rd St., Alsip, IL 60658
(708) 389-8000 ext 195, fax: (708) 371-0627

Mason, L.E. Co.
98 Business St., Boston, MA 02136
(617) 361-1710, fax: (617) 361-6876

Philips Lighting Co.
200 Franklin Sq., Dr. Somerset, NJ 08875
(908) 563-3000, (800) 631-1259, fax: (908) 563-3975

Rig-A-Light
P.O. Box 12942, Houston, TX 77217
(713) 943-0340, fax: (713) 943-8354

Sterner Lighting Systems
351 Lewis Ave., Winisted, MN 55395
(320) 485-2141, fax: (320) 485- 2899

Thomas and Betts
Corporate Headquarters, Memphis, TN 38119
(800) 888-0211, fax: (800) 888-1366

Unique Solution/Manville
515 McKinley Ave., Newark, OH 43055
(614) 349-4194

Infrared Sterilization

Equipment Suppliers

Medifor-X Corporation®
1 Shelton Rock Lane, Danberry, CT 06810
(800) 342-1646, (203) 792-0323, fax: (203) 792-0024

Low-Volume Infectious Waste

Equipment Suppliers

Treatment

Chemical-Mechanical
STERIS Corporation (Ecocycle 10)
5960 Heisley Road, Mentor, OH 44060
(216) 354-2600, fax: (216) 639-4450

Electrochemical
Brinecell, Inc. (Ster-O-Lizer)
P.O. Box 27488, Salt Lake City, UT 84127
(801) 973-6400, fax (801) 973-6463

Thermal-Mechanical
MediVators, Inc. (DSI 40 and DSI 2000)
2995 Lome Oak Circle Suite 10, Eagan, MN 55121-0387
(612) 405-1661, fax: (612) 405-1881

Resistance Sterilization
Princeton, PMC, Inc. (SDS)
151 South Pfingston Rd., Unit T, Deerfield, IL 60015
(800) 862-1125, fax: (847) 272-2584

Information on Efficiency Technologies

This list provides EPRI resources on efficiency technologies identified in this guidebook. Copies of these publications can be ordered through the EPRI Distribution Center, (510) 934-4212.

Energy-Efficient Lighting

Proceedings: Efficient Lighting 1993: A Lighting Symposium for Electric Utility Lighting and DSM Professionals, TR-105963, January 1996.

Electronic Ballasts, BR-101886, May 1993.

High-Intensity Discharge Lighting, BR-101739, May 1993.

Advanced Lighting Technologies Application Guidelines: 1990, TR-101022-R1, May 1993.

Lighting Fundamentals Handbook, TR-101710, March 1993.

Commercial Lighting Efficiency Resource Book, CU-7427, September 1991.

Additional information on lighting can be obtained from the EPRI Lighting Information Office, (800) 525-8555.

Energy-Efficient HVAC

Electric Chiller Handbook, TR-105951, February 1996.

Space-Conditioning System Selection Guide, TR-103329, December 1993.

Packaged Terminal Heat Pump Assessment Study, CU-6777, March 1990.

Additional information on HVAC can be obtained from the EPRI HVAC&R Center, (800) 858-3774.

Energy-Efficient Office Equipment

Guide to Energy-Efficient Office Equipment, TR-102545-R1, February 1996.

Proceedings: Energy-Efficient Office Technologies, TR-105549, December 1995.

Electronic Office Equipment: Ensuring Energy Efficiency in the Workplace, BR-101965, April 1993.

Healthcare Initiative

New Technology for Medical Device Sterilization: A Resource Guide, CR-106942, September 1996.

Indoor Air Quality Health Effects Primer, CR-106639, June 1996.

Waste Minimization in the Healthcare Industry: A Resource Guide, CR-106627, May 1996.

Tuberculosis Resource Guide, CR-106146, January 1996.

Evaluation and Testing of Electron Beam Processing of Medical Waste, CR-105378, July 1996.

Additional information on the EPRI Healthcare Initiative can be obtained from the Northeast Regional Community Environmental Center, (800) 424-3774.

Trade Associations

American Group Practice Association
1422 Duke Street, Alexandria, VA 22314-3420
(703) 838-0033, fax: (703) 548-1890

American Hospital Association
840 N. Lake Shore Drive, Chicago, IL 60611
(312) 280-6000, fax: (312) 280-5979