Welcome

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1 LU|HSW

ASPE American Society of Plumbing Engineers CEU PROVIDER

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The Importance of Effective Handwashing and Its Impact on Global Health

About This Course

Designing public handwashing solutions that are code compliant, with reliable performance and efficiencies in water and energy use, can present several challenges to both the architect and plumbing engineer.

This course will review current plumbing codes, public health agency guidelines, and regulatory statutes. Insights into specific water heating technologies and system designs will be covered.

Learning Objective 1

Participants will gain an understanding of service water heating code bodies that dictate design parameters for safe and efficient hot water delivery.

Code considerations:

UL	Underwriters Laboratories
UPC	Uniform Plumbing Code
IPC	International Plumbing Code
IECC	International Energy Conservation Code
ANSI	American National Standards Institute
NEC	National Electrical Code

Learning Objective 2

Participants will gain an understanding of current public health agency guidelines specific to handwashing and the effects on health.

Agencies covered:

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CDC	Centers for Disease Control & Prevention
CMS	Centers for Medicare & Medicaid Services
DoE	Department of Energy
EPA	Environmental Protection Agency
OSHA	Occupational Safety and Health Administration
WHO	World Health Organization

Learning Objectives 3, 4 & 5

Participants will learn how water temperature can impact—both positively and negatively—the health efficacy of handwashing.

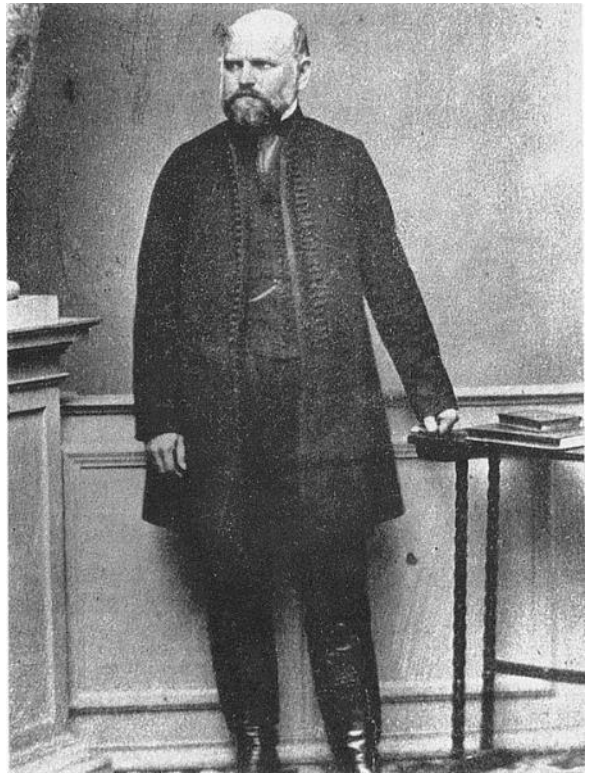
Participants will be able to explain the differences between traditional and non-traditional types of water heating technologies, and identify strengths and limitations of each in handwashing applications.

Participants will gain an understanding of the benefits gained with tankless electric water heating systems.

Handwashing, 1847

Vienna, Austria

- First Clinic: 3x mortality rate
- Second Clinic: midwives
- Cadaverous particles
- Suggested doctors scrub their hands with a chlorinated lime solution before leaving the autopsy room.
- After practices were implemented, mortality rate fell to below 1 percent.
- Unfortunately, decades passed before handwashing would be commonly accepted.
- U.S. Civil War, 1861 - 1865
- Louis Pasteur, Germ Theory of Disease, 1881
- Joseph Lister, initially mocked, 1879 Listerine antiseptic



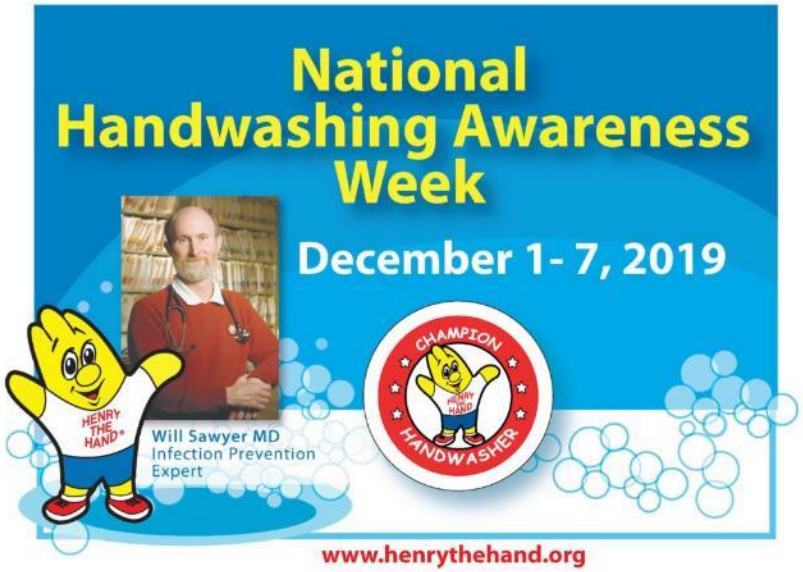
From source: Ignaz Semmelweis 1863

Ignaz Semmelweis, a 19th century Hungarian obstetrician, is now widely credited with discovering the medical importance of washing our hands. Died 1865.

Source: Dana Tulodziecki, https://www.jstor.org/stable/10.1086/673935?read-now=1&seq=1

National Handwashing Initiatives

2001: Henry the Hand Foundation



Today: CDC.gov/handwashing

7.8 billion*

The first Global Handwashing Day was held in 2008, when over 120 million children around the world washed their hands with soap in more than 70 countries.

Source: https://globalhandwashing.org/global-handwashing-day/about-ghd/
* United Nations, March 2020

Handwashing | Private vs. Public

- **Private:** In the classification of plumbing fixtures “private” applies to fixtures in residences and apartments, and to fixtures in nonpublic toilet rooms of hotels and motels and similar installations in buildings where the plumbing fixtures are intended for utilization by a family or an individual.

- **Public:** In the classification of plumbing fixtures, “public” applies to fixtures in general toilet rooms of schools, gymnasiums, hotels, airports, bus and railroad stations, public buildings, bars, public comfort stations, office buildings, stadium, stores, restaurants and other installations where a number of fixtures are installed so that their utilization is similarly unrestricted.

Source: International Plumbing Code (IPC), November 2018

Benefits of Handwashing

Handwashing halts the spread of infection and is effective in preventing the spread of some diseases, including:

- Cholera
- Diarrhea
- Healthcare-Associated Infections
- Helminthic Infections (parasitic worms)
- Influenza
- Stunting
- Viruses

Successful handwashing behavior change requires both the availability of facilities (e.g. a handwashing station with soap and water) and adoption of a good handwashing habit.

https://globalhandwashing.org/learn/latest-research/

Protecting Vulnerable People

Young, old, immune compromised, and those with underlying health conditions.

Effective Public Handwashing

Is Dependent Upon
Effective Service Water Heating

- Efficient
- Compliant
- Accessible
- Safe
- Consistent

(watch for these banners as we go forward)

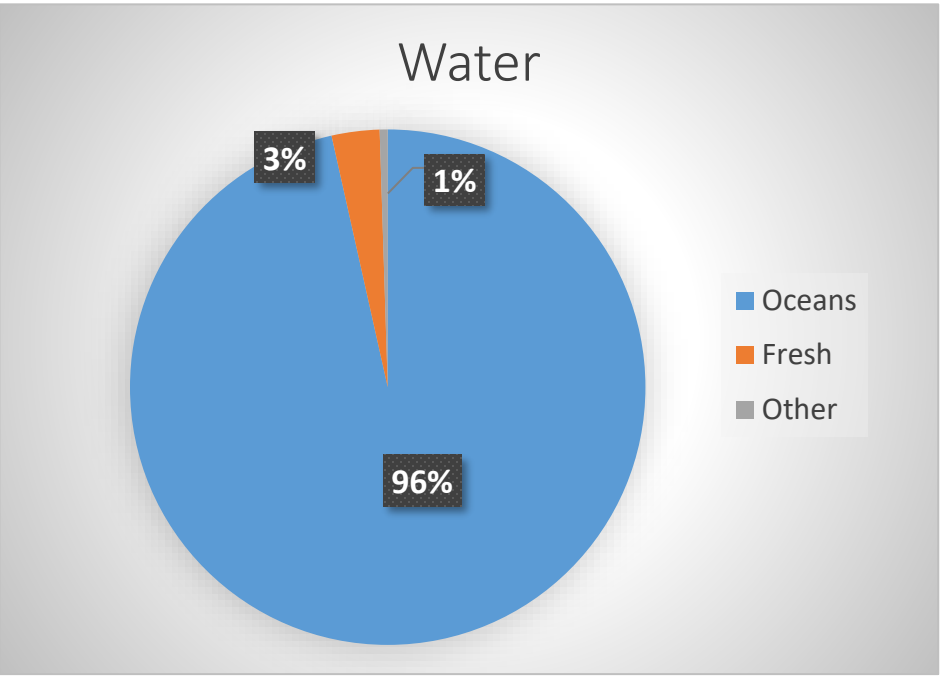
- Efficient
- Accessible
- Safe

A World of Water

About 71 percent of Earth’s surface is water-covered.

- Accessible
- Safe

Of That 71 Percent…



Fresh water makes up about 3% of all water on earth, and nearly **65% of this drinkable water is tied up in glaciers.**

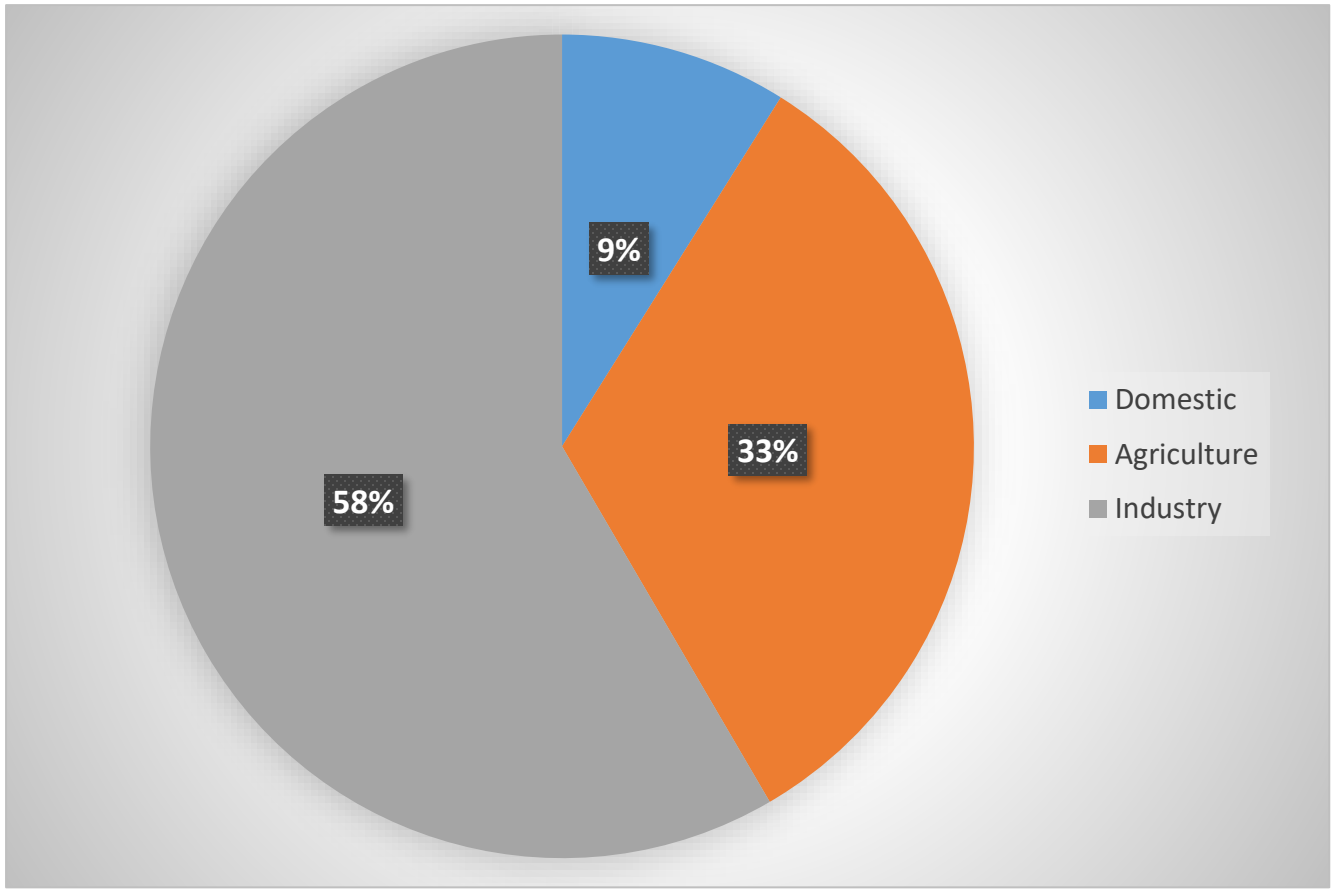
Rivers, streams, lakes, and dams that hold freshwater contain 1% of **potable water** while groundwater accounts for 0.3%.

Potable water is essential for all life forms to thrive.

If the world's water supply were only 26 gallons, our **usable water supply** of fresh water would be only about **one-half teaspoon**.

Source: U.S. Geological Survey

Water Use in the United States



Over 600 gallons per day per person in the U.S. is being diverted for farm irrigation and livestock use from natural aquatic sources.

More than half the people in the U.S. get their water from **groundwater**.

Source: U.S. Bureau of Reclamation: https://www.usbr.gov/mp/arwec/water-facts-ww-water-sup.html

Traditional Consumer Experience

125 feet of ¾" pipe = 3.14 gal

10 x per day = **31** gal

1 year = **11,461** gal

25 M homes = **300 B** gal/yr.

- Efficient
- Consistent

Waiting for hot water **wastes** water

Other costs to consider:
Public water supply & sewer

Water Use in the United States

Home Water Use (approximate)	
Gallons	**Activity**
3	Shaving and allowing the water faucet to run
1.6-5	Flushing a toilet
5	Brushing your teeth and allowing the water faucet to run
8	Cooking 3 meals
8	Cleaning house
10	Washing dishes for 3 meals
20-30	Washing clothes
30	Washing dishes and allowing the water faucet to run
30-40	Watering lawn
30-40	Washing a car
30-40	Taking a bath
40	8 minute shower (5 gallons/minute)

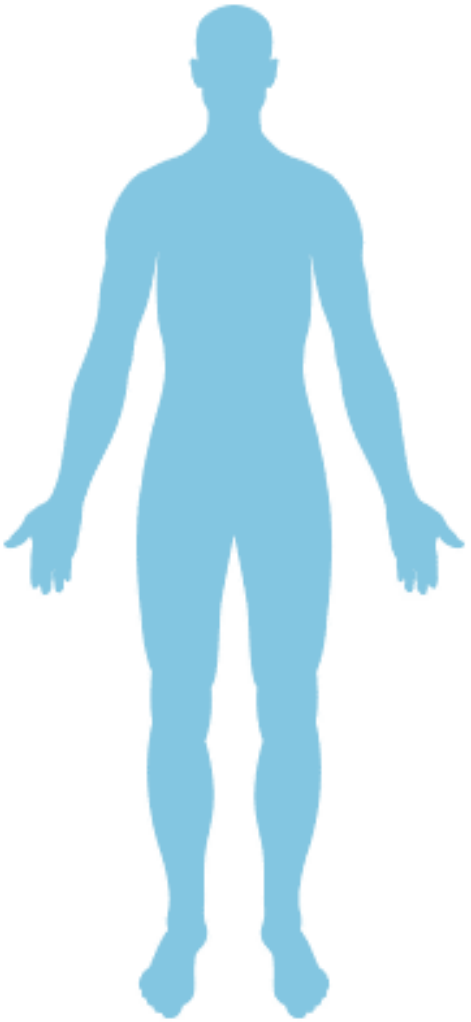
Source: U.S. Geological Survey

A leak that fills up a coffee cup in 10 minutes will waste over **3,000 gallons** of water in a year. That's 65 glasses of water every day for a year.

A leaky toilet can waste over **22,000 gallons** of water in one year; enough to take three baths every day.

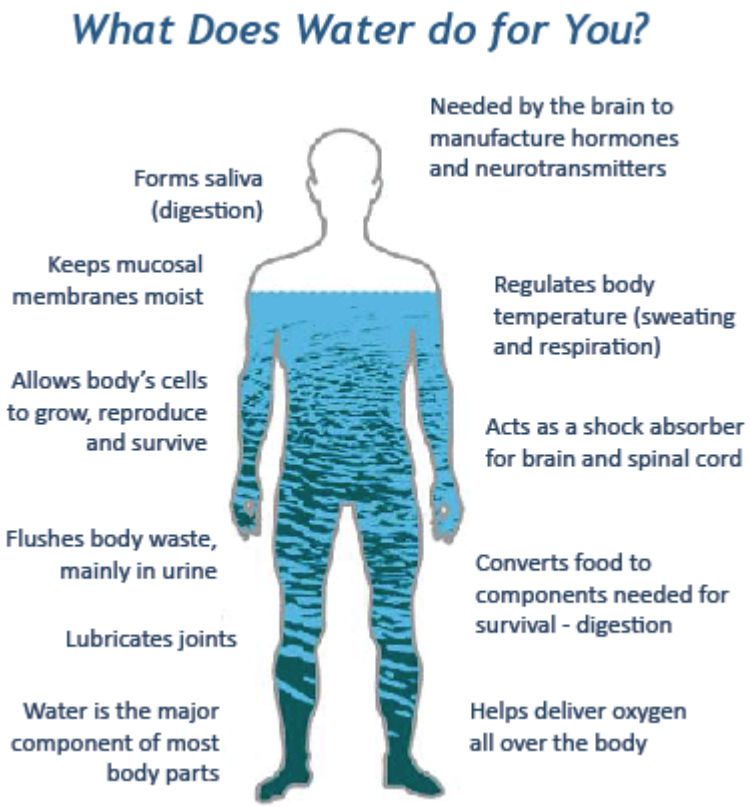
The Human Body Water & Bacteria

Handwashing Helps to Balance Bacteria



Water & Bacteria Balance is Vital

Up to 60% of the human adult body is water

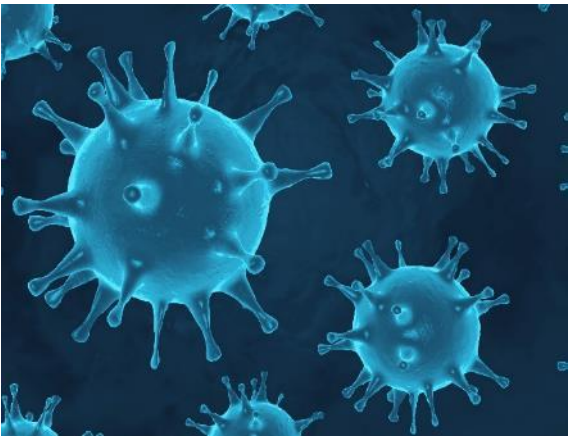


The human body contains trillions of microorganisms — outnumbering human cells by 10 to 1. Because of their small size, however, microorganisms make up only about 1 to 3 percent of the body's mass (in a 200-pound adult, that's **2 to 6 pounds of bacteria**), but **play a vital role** in human health.

Source: U.S. Geological Survey & National Institutes of Health

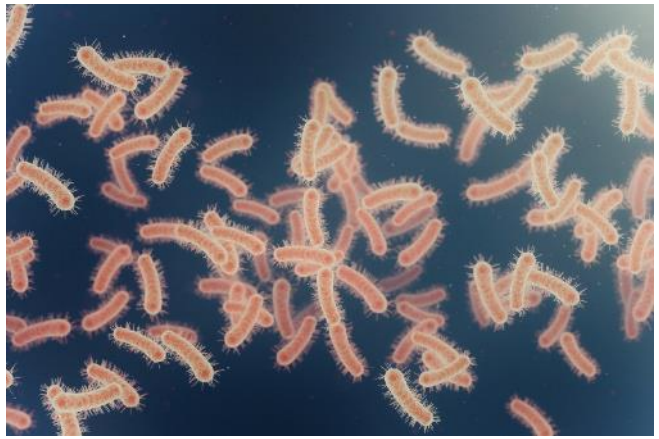
Handwashing Helps Mitigate Risks

There are 219 virus species that are known to be able to infect humans.



Coronavirus

Salmonella



E coli

Protozoan

Source: US National Library of Medicine National Institutes of Health

Polio: 100s to 1000s of Years

Vaccine developed in 1953

- Polio is a viral infection that can cause paralysis and death in its most severe forms.
- It can spread easily from person to person.
- The World Health Organization (WHO) aim is to eradicate polio completely.
- In areas with poor sanitation, the virus easily spreads from feces into the water supply, or, by touch, into food.
- Because polio is so contagious, direct contact with a person infected with the virus can cause polio.
- Individuals who carry the poliovirus can spread it via their feces for weeks, even if they have shown no symptoms themselves.

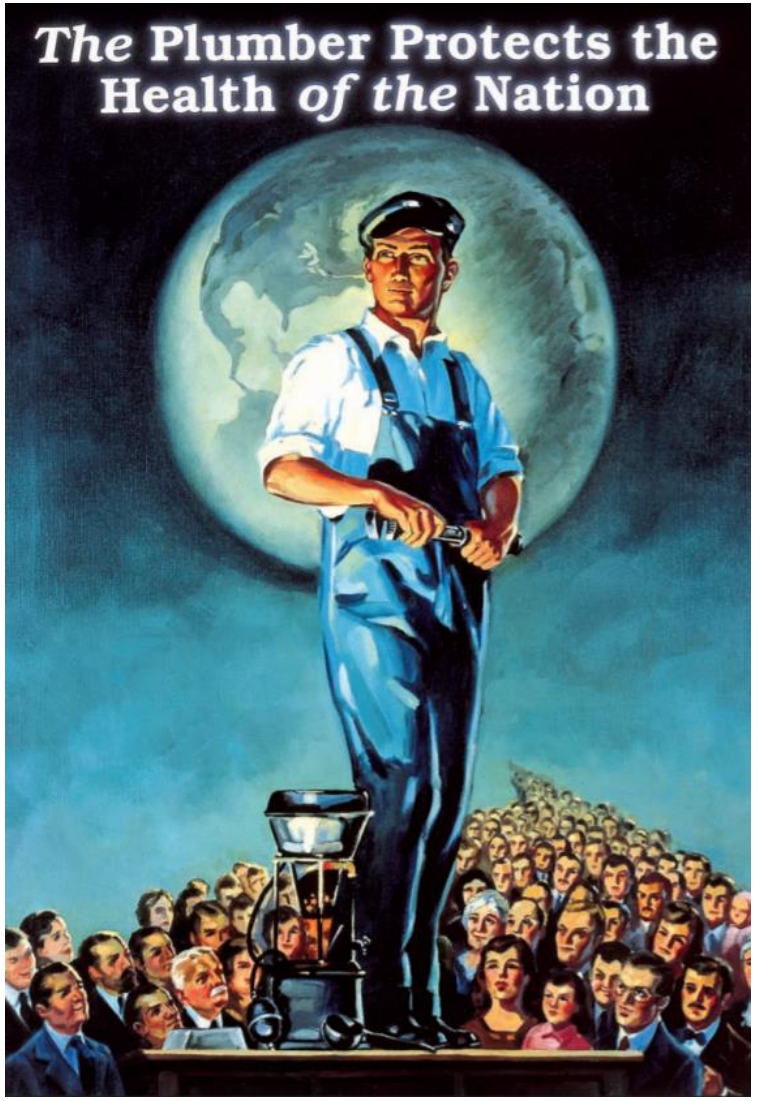


Image source & copyright American Standard.

Source: https://www.medicalnewstoday.com/articles/155580#what-is-polio

Handwashing: A Best Defense

For everyone, everywhere, any time of year

Diarrhea and pneumonia are leading causes of death for children under the age of five.

Handwashing with soap is among the most effective and inexpensive ways to prevent these diseases. This simple behavior can save lives, cutting diarrhea by almost one-half and acute respiratory infections by nearly one-quarter.

Handwashing with soap **impacts** not just **health** and **nutrition**, but also **education**, **economics**, and **equity**.

Sources: Centers for Disease Control & Prevention, World Health Organization, Globalhandwashing.org

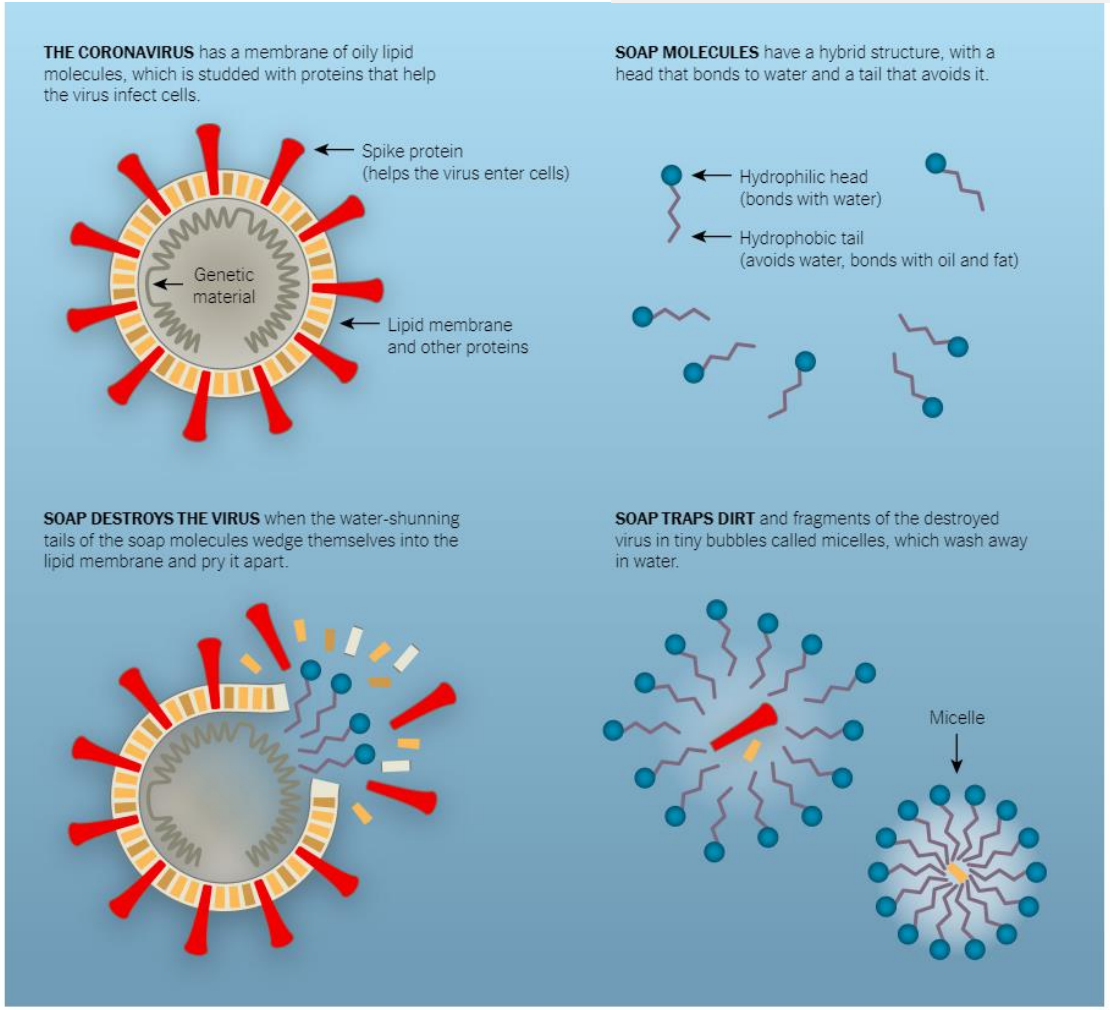
Handwashing: Water Temperature is Important

Temperatures that kill germs are unsafe for handwashing.

- Efficient
- Compliant
- Accessible
- Safe
- Consistent

Soap vs. Virus

- Washing with soap and water will destroy and dislodge many microbes, including coronavirus
- Water temperature improves the effectiveness of soap

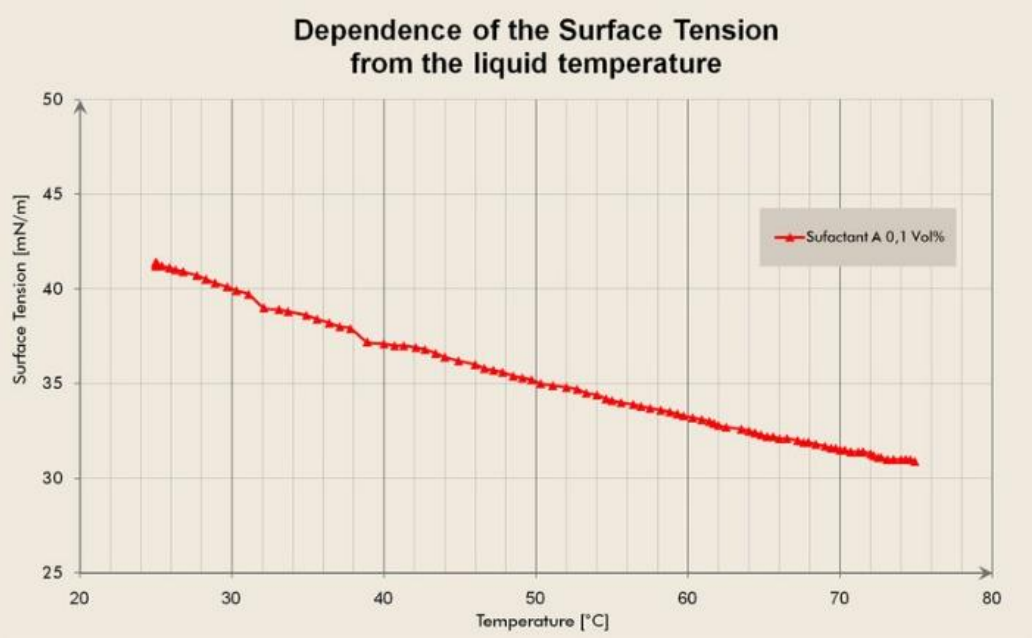


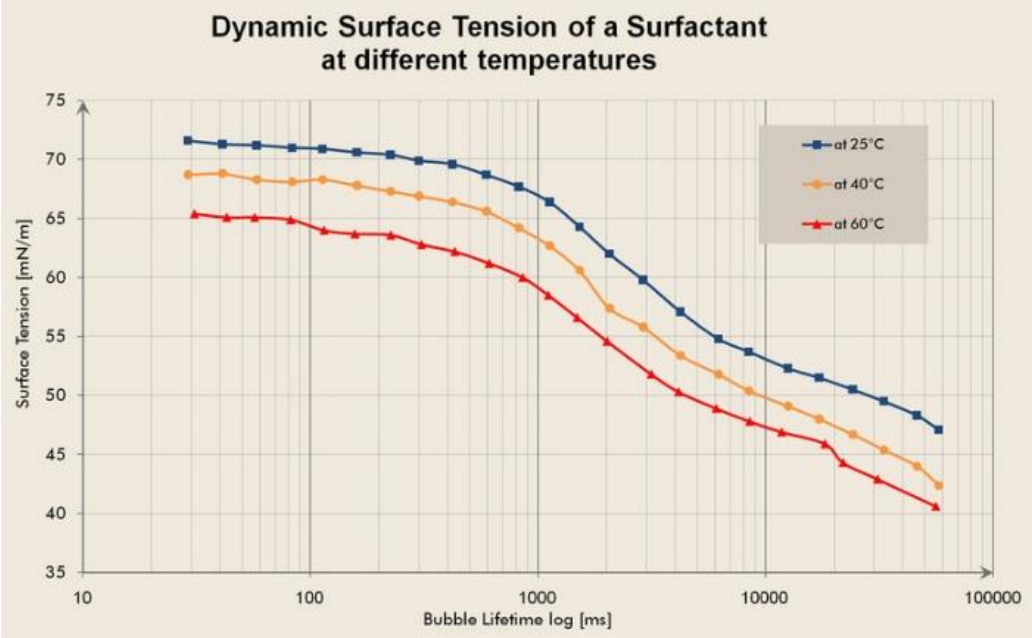
Source: https://www.nytimes.com/2020/03/13/health/soap-coronavirus-handwashing-germs.html

Soap & Water Temperature

The effects that surfactants have on the surface tension are temperature dependent.

Warmer water helps soaps to break the bond of oils on skin and surfaces.





25 °C = 77 °F
40 °C = 104 °F
60 °C = 140 °F

Source: SITA Lab: https://www.sita-lab.com/applications/measuring-surface-tension/surfactants-temperature-influence-on-surface-tension/

Ideal Handwashing Temperature

- Temperature is subjective
- Human behavior
  - Too cold or too hot can have negative results
- **Rinsing thoroughly is key**
  - “Water works as a physical cleanser and washes the organisms and microbes off the hands.”

    Dr. Raymond Pontzer
    Director of Infection Prevention, University of Pittsburgh Medical Center

- Efficient
- Compliant
- Accessible
- Safe
- Consistent

Public Handwashing Temperatures

- National Restaurant Association Educational Foundation recommends water temperature **for handwashing should be at least 100 °F**
- International Food Safety & Quality Network guidelines suggest **water temperatures between 95 °F to 113 °F**
- Public handwashing temperatures are regulated by codes

- Efficient
- Compliant
- Accessible
- Safe
- Consistent

Source: http://www.foodprotect.org/issues/packets/2012Packet/issues/I_036.html

Preventing Scald

- Tap Water Scalds – Consumer Product Safety Commission
  - Most adults will suffer **third-degree burns** if exposed to 150 °F water for 2 seconds.
  - Burns will also occur with a six-second exposure to 140 °F water.
- Understanding Potential Water Heater Scald – ASSE International
  - Water temperatures **over 120 °F at the point-of-use** are considered a hazard.

Source: www.cpsc.gov/s3fs-public/5098.pdf and www.asse-plumbing.org/waterheaterscaldhazards.pdf

Handwashing Summary of Key Points

Handwashing saves lives.

Increasing duration of scrubbing with soap and thoroughly rinsing is proven to be **the most effective way to mitigate the risk** of exposure to and transmission of intestinal and respiratory diseases.

- People wash hands more if sink & soap are visible, accessible, and sanitary
- Using soap is important and is proven to work better with warm water

Code Considerations

Safe and Efficient Water Delivery

Code Bodies

Uniform Plumbing Code

Designated as an American National Standard, the Uniform Plumbing Code (**UPC**) is a model code developed by the International Association of Plumbing and Mechanical Officials (IAPMO) to govern the installation and inspection of plumbing systems as a means of promoting the public's health, safety and welfare.

International Plumbing Code

The International Plumbing Code (**IPC**) is a plumbing code and standard which sets minimum requirements for plumbing systems in their design and function, and which sets out rules for the acceptances of new plumbing-related technologies.

National Electrical Code

The National Electrical Code (**NEC**), or NFPA 70, is a regionally adoptable standard for the safe installation of electrical wiring and equipment in the United States. It is part of the National Fire Codes series published by the National Fire Protection Association (NFPA), a private trade association

Source: Wikipedia, November 2018

Code Bodies

International Energy Conservation Code

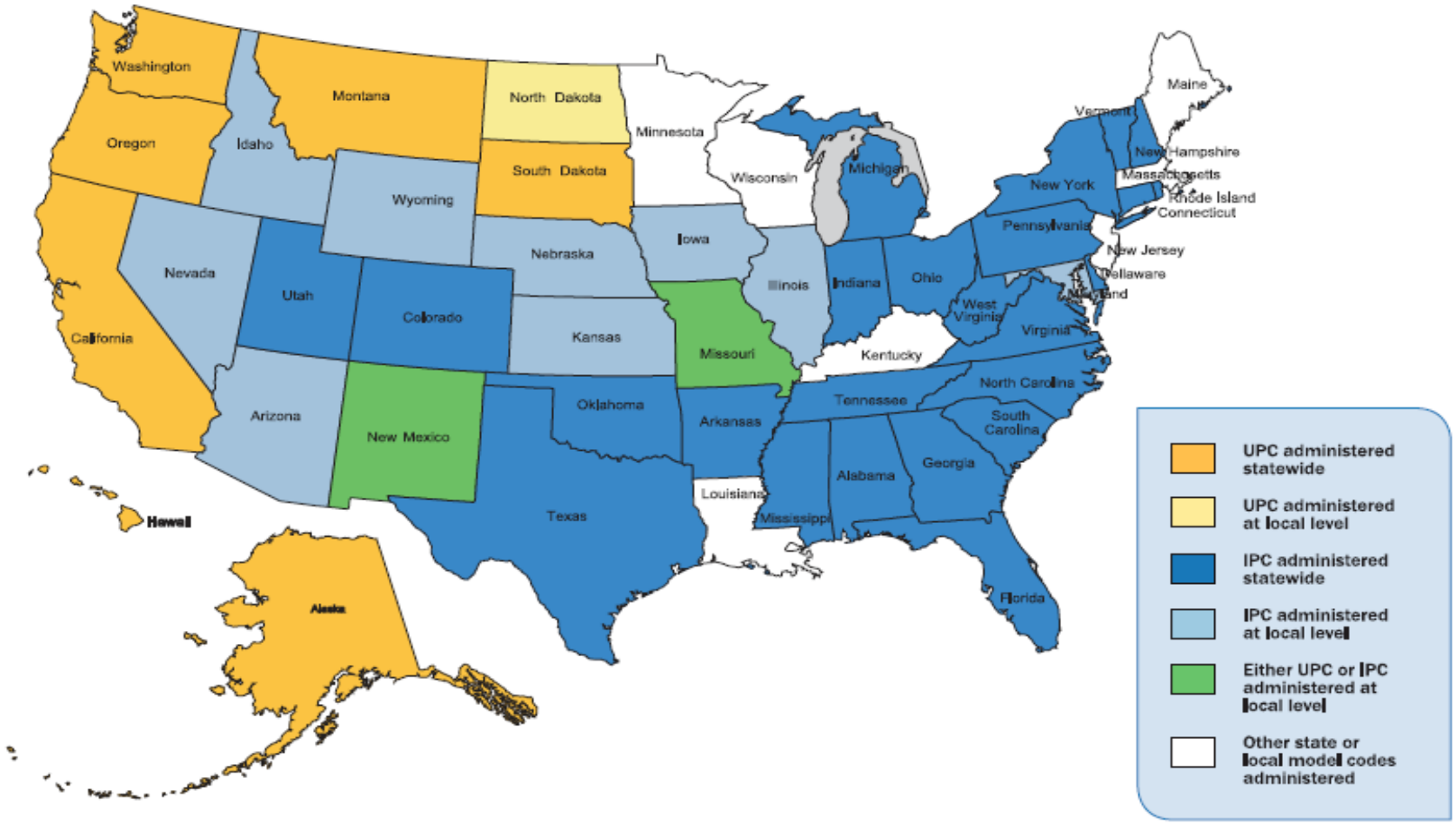
The International Energy Conservation Code (**IECC**) is a building code created by the International Code Council in 2000. It is a model code adopted by many states and municipal governments in the United States to establish minimum design and construction requirements for energy efficiency.

American National Standards Institute

American National Standards Institute (**ANSI**) Codes. ANSI codes are standardized numeric or alphabetic codes issued by the ANSI to ensure uniform identification of geographic entities through all federal government agencies.

Source: Wikipedia, November 2018

Model Plumbing Code Adoption



- Efficient
- Compliant
- Accessible
- Safe
- Consistent

Source: https://sfwater.org/modules/showdocument.aspx?documentid=5609

What do these codes govern?

- Efficient water delivery
- Efficient energy consumption
- Safe, reliable performance
- User hygiene and safety
- Design liability/mitigating risk

- Efficient
- Compliant
- Accessible
- Safe
- Consistent

2018 International Plumbing Code (IPC)

Chapter 4: Fixtures, faucets and fixture fittings.

- About this chapter: **Plumbing fixtures are required to be installed for nearly every building as toilet facilities** (water closets and lavatories) are needed by the occupants of a building. Additional fixtures for washing, bathing, and culinary purposes are also necessary where occupants dwell in buildings. Chapter 4 specifies the **minimum number and type of plumbing fixtures** for buildings based on the description use of the building. Because fixture design and quality are paramount **to ensure that plumbing fixtures operate properly,** this chapter also specifies numerous product and material standards for plumbing fixtures.

- Compliant
- Accessible
- Safe

International Plumbing Code

IPC Chapter 4, Table 403.1 (sample)

Minimum Number of Required Plumbing Fixtures

Classification	Description	Lavatories	
		Male	Female
Assembly	Theaters	1 per 200	
	Nightclubs, bars, etc.	1 per 75	
	Restaurants, food courts	1 per 200	
	Places of worship	1 per 200	
	Passenger terminals	1 per 750	
Business	Offices, banks, light industrial,…	1 per 40 for the first 80…	
Educational	Educational facilities	1 per 50	
Factory/industrial	Fabrication, assembly, processing	1 per 100	
Institutional	Prisons	1 per cell	
	Medical care in hospitals, nursing homes	1 per room	
	Visitors in hospitals, nursing homes	1 per 15	

Source: https://codes.iccsafe.org/content/IPC2018/chapter-4-fixtures-faucets-and-fixture-fittings

Public Handwashing Temperature Control

Code updates have greatly impacted this application over the last few years.



Public Handwashing Temperature Control

- Compliant
- Safe

2018 Uniform Plumbing Code (UPC)

- 407.3 Limitation of Hot Water Temperature for Public lavatories. Hot water delivered from public-use lavatories shall be **limited to a maximum temperature of 120 °F** by a device that is in accordance with ASSE 1070 or CSA B 125.70. The water heater thermostat shall not be considered a control for meeting this provision.

Public Handwashing Temperature Control

- Efficient
- Compliant
- Safe

Appendix L 603.4.5.3

Sustainable Practices Outlet Temperature Controls.

Temperature controlling means shall be provided to **limit the maximum temperature** of water delivered **from lavatory faucets** in public facility restrooms to **110 °F**.

Source: Universal Plumbing Code (UPC), November 2018

Public Handwashing Temperature Control

- Compliant
- Safe

2015 International Plumbing Code (IPC)

416.5 Tempered water for public hand-washing facilities.

- Tempered water shall be delivered from lavatories and group wash fixtures located in public toilet facilities provided for customers, patrons and visitors. Tempered water shall be delivered through **an approved water-temperature limiting device** that conforms to ASSE 1070 or CSA B125.7.
- Tempered water is defined as water having a temperature range between **85 °F and 110 °F**.

Image source: watts.com

- Efficient
- Compliant

International Energy Conservation Code (IECC)

Hot Water Delivery

Service Water Heating | C404.5, C404.5.1, C404.5.2

Source: https://up.codes/s/service-water-heating-mandatory

IECC Considerations

- Efficient
- Compliant

Internationally, code officials recognize the need for a modern, up-to-date energy conservation code addressing the design of energy-efficient building envelopes and installation of energy-efficient mechanical, lighting and power systems through requirements emphasizing performance.

Source: International Code Council (ICC), November 2018

Today’s IECC is known for

Conservation

It has a proven track record addressing the design of energy-efficient building envelopes and installation of energy-efficient systems.

Embrace of New Technology

The IECC and its predecessors have a tradition of innovation while protecting the health and safety of the public.

Correlation

The IECC is specifically correlated to work with International Code Council’s (ICC) family of codes.

Open and Honest Code Development Process

Revised on a 3-year cycle through ICC's highly respected consensus code development process that draws upon the expertise of hundreds of plumbing, building, and safety experts from across North America.

Source: International Energy Conservation Code (IECC) November 2018

International Energy Conservation Code (IECC)

Section C404

Service Water Heating (mandatory)

- Efficient
- Compliant

C404.5 Efficient heated water supply piping

- Heated water supply piping shall be in accordance with Section C404.5.1 or C404.5.2.
- The **flow rate** through 1/4 inch piping shall not be greater than 0.5 GPM. The flow rate through 5/16 inch piping shall not be greater than 1 GPM. The flow rate through 3/8 inch piping shall be not greater than 1.5 GPM.

Pipe Diameter	Flow Rate
1/4 inch	≤ 0.5 GPM
1/2 inch	≤ 1 GPM
3/8 inch	≤ 1.5 GPM

Source: https://up.codes/s/service-water-heating-mandatory

Pipe & Water Volume

- Efficient
- Compliant

C404.5.2 Maximum allowable pipe volume method

- The water volume in the piping shall be calculated in accordance with Section C404.5.2.1. Water heaters, circulating water systems and heat trace temperature maintenance systems shall be considered sources of heated water.
- The volume from the nearest source of heated water to the termination of the fixture supply shall be as follows:
- **For a public lavatory faucet: not more than 2 ounces.**
- For other plumbing fixtures or plumbing appliances; not more than 0.5 gallon.

Source: https://up.codes/s/service-water-heating-mandatory

International Energy Conservation Code (IECC)

Pipe Length (Source to termination)

- Efficient
- Compliant

C404.5.1 Maximum allowable pipe length method

- The maximum allowable piping length from the nearest source of heated water to the termination of the fixture supply pipe shall be in accordance with the following. Where the piping contains more than one size of pipe, the largest size of pipe within the piping shall be used for determining the maximum allowable length of the piping in Table C404.5.1.
- **For a public lavatory faucet, use the "Public lavatory faucets" column in Table C404.5.1.**
- For all other plumbing fixtures and plumbing appliances, use the "Other fixtures and appliances" column in Table C404.5.1.

Table C404.5.1
Piping Volume and Maximum Piping Lengths

Nominal Pipe Size (inches)	Volume (liquid ounces per foot length)	Maximum Piping Length (feet)	
		Public lavatory faucets	Other fixtures and appliances
3/8	0.75	3	50
1/2	1.5	2	43
3/4	3	0.5	21
1 1/4	8	0.5	8

Source: https://up.codes/s/service-water-heating-mandatory

Regulating Agencies

Handwashing Guidelines

Why Humans Need Regulations

- We touch everything, and then our face

A 2015 study on face touching documented the alarming number of times we do it. While medical students attended a lecture, the researchers filmed them and counted the number of times they touched any part of their faces. Over the course of an hour, students touched their faces, on average, **23 times**. **Nearly half of the touches were to the eyes, nose, or mouth: what infectious disease researchers call "the T-zone."**

Source: https://www.ncbi.nlm.nih.gov/pubmed/25637115

Handwashing Alternatives

- Hand sanitizers have limitations
  - Supply vs demand
  - Are less effective
- Gloves
  - Supply vs demand
  - Proper use

Alcohol-based hand sanitizers **don't kill ALL** types of germs, such as a stomach bug called norovirus, some parasites, and Clostridium difficile, which causes severe diarrhea.

https://www.cdc.gov/handwashing/pdf/hand-sanitizer-factsheet.pdf

Generally, when people wear gloves it's actually less sanitary than when they don't wear gloves, with the exception of when employees have cuts or open sores on their hands. A hand-hygiene study was conducted by the CDC and found that hand washing rates were significantly lower when gloves were worn.

https://cleanersolutions.net/handwashing-vs-gloves-in-commercial-restaurants/

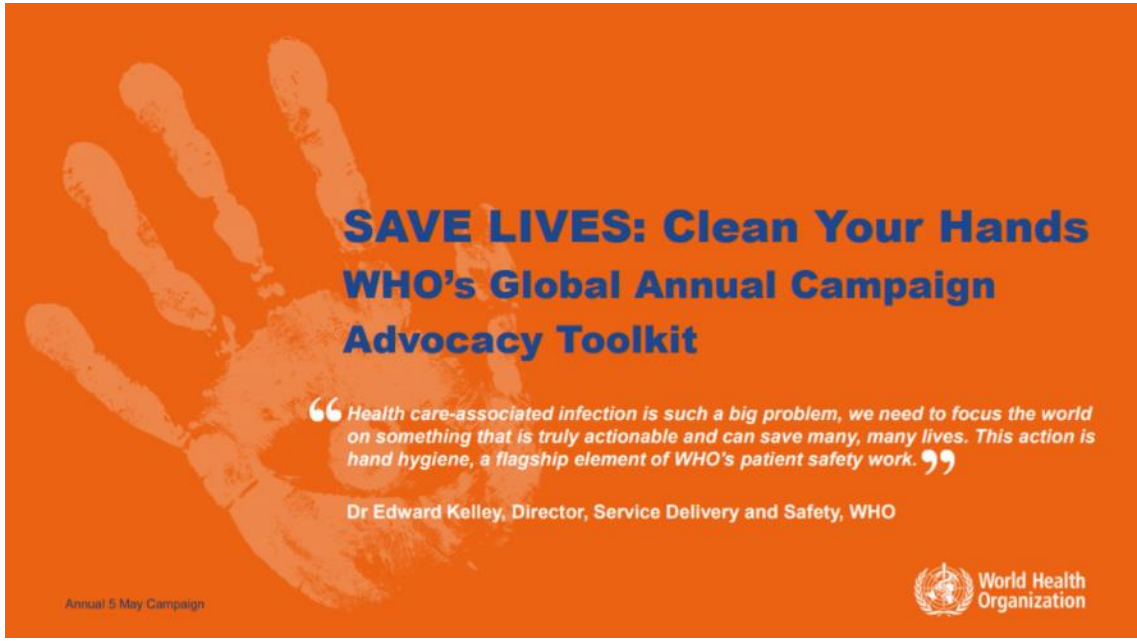
The World Health Organization

Global Programs & Education

- Accessible
- Safe

Hand Hygiene

- **Infection Prevention and Control** is critical to achieve **Universal Health Coverage** as it is a practical and evidence-based approach with demonstrated impact on **quality of care and patient safety** across all levels of the health system.

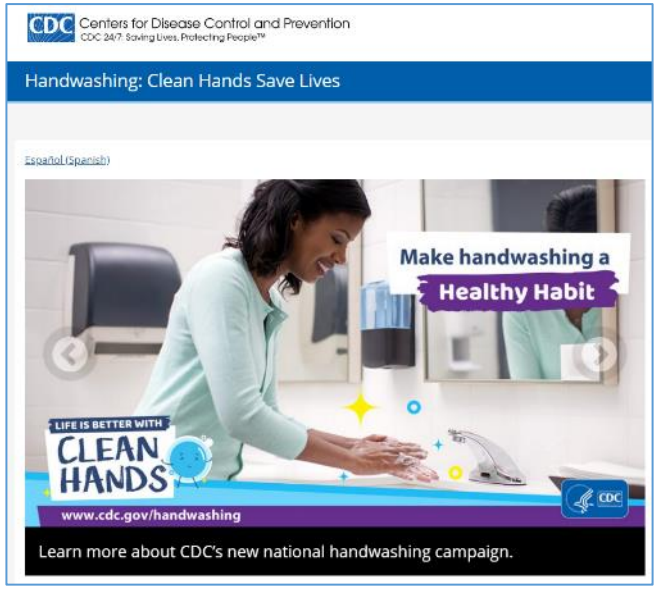


Centers for Disease Control and Prevention

CDC Guidelines & Education

- Goal: mitigating risk
- 2,774 search results returned for hand washing regulations
  - General public
  - Healthcare facilities
  - Commercial settings
  - Animal contact exhibits

- Compliant
- Accessible
- Safe



Centers for Disease Control and Prevention

Hand Hygiene for Surgery

- Compliant
- Accessible
- Safe

- Remove debris from underneath fingernails using a nail cleaner **under running water**
- When performing surgical hand antisepsis using an antimicrobial soap, **scrub hands and forearms** for the length of time recommended by the manufacturer, usually 2–6 minutes.
- Before applying the alcohol solution, **prewash hands and forearms** with a non-antimicrobial soap and dry hands and forearms completely
- **Bacterial growth is slowed** after preoperative scrubbing with an antiseptic agent
- **Reducing resident skin flora on the hands** … reduces the risk of bacteria being released into the surgical field if gloves become punctured or torn during surgery

Studies show that some healthcare providers practice hand hygiene less than half of the times they should. Healthcare providers might need to clean their hands as many as **100 times per 12-hour shift**, depending on number of patients and intensity of care.

Food Worker Handwashing

- Compliant
- Accessible
- Safe

What the Study Found

Food workers were more likely to wash their hands when they should:

- Before food preparation than with other work activities.
- When workers were not busy.
- In restaurants where workers had food-safety training.
- **In restaurants with more than one hand sink.**
- **In restaurants with a hand sink in view of the observed worker.**

https://www.cdc.gov/nceh/ehs/EHSNet/plain_language/Food-Worker-Handwashing-Restaurant-Factors.htm

American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASHRAE Guideline 12

- Compliant
- Safe

- ASHRAE Guideline 12 is intended for use by owners of human-occupied buildings and those involved in the design, construction, installation, commissioning, management, operation, maintenance, and service of centralized building water systems and components.
- To provide information and guidance to assist in control of legionellosis associated with building water systems.
- ASHRAE Standard 188, “Legionellosis: Risk Management for Building Water Systems.”

Source: https://www.ashrae.org/about/news/2018/ashrae-seeks-third-round-of-comments-on-legionella-guideline-12

- Compliant
- Safe

Centers for Medicare & Medicaid Services (CMS)

Memo 17-30

Expectations for Healthcare Facilities

CMS expects Medicare and Medicare/Medicaid certified healthcare facilities to have water management policies and procedures to reduce the risk of growth and spread of Legionella and other opportunistic pathogens in building water systems.

Facilities must have water management plans and documentation that, at a minimum, ensure each facility:

> Conducts a facility risk assessment to identify where Legionella and other opportunistic waterborne pathogens (e.g. Pseudomonas, Acinetobacter, Burkholderia, Stenotrophomonas, nontuberculous mycobacteria, and fungi) could grow and spread in the facility water system.

Source: https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/QSO17-30-HospitalCAH-NH-REVISED-.pdf

Learn More: Water Safety

Scanlon, M. *Raising Awareness: Water Safety During Construction Activities for Engineering Design Professionals.* Paper presented at: American Society of Plumbing Engineers (ASPE) 2019 Technical Symposium, 2019, 25 - 27 October, Pittsburgh (PA).

Healthcare facilities with concerns about immunocompromised patients have been early adopters of water safety standards to maintain a healthy built environment. **With the Centers for Medicare and Medicaid (CMS) publication of Memo 17-30, healthcare facilities (acute care, critical access hospitals, and skilled nursing facilities) will need to survey their facilities for water safety not only for existing buildings, but also before construction begins for renovations, additions, or modifications to existing buildings, and prior to occupancy of a new building**.

This is a lofty goal when there has been minimal training of facility management and infection preventionist professionals about the dangers of construction activities impacting waterborne pathogens and ensuing disease in patient care settings. In addition to identifying the hazards, there has been minimal effort and a lack of understanding about establishing hazard controls, locations for controls, monitoring procedures, control limits, and corrective actions, as well as the necessary verification and validation procedures.

Molly M. Scanlon, PhD, FAIA, FACHA
Director of Standards, Compliance and Research

phigenics Independent Water Management

Molly M. Scanlon, PhD, FAIA, FACHA is an Environmental and Occupational Health Scientist, as well as a licensed and certified Healthcare Architect currently working with Phigenics as the Director of Research and Innovation. She has more than 25 years of planning and design experience for healthcare settings to create environments benefiting the health, safety, and welfare of patients, nurses, physicians, and staff. Dr. Scanlon is serving as: an adjunct faculty member at the University of Arizona – College of Public Health; an appointed member of the American Institute of Architects Design and Health Leadership Group; a Fellow in the American Institute of Architects; and a Fellow in the American College of Healthcare Architects.

Source: https://info.phigenics.com/blog/author/molly-m-scanlon-phd-faia-facha

Occupational Safety and Health Administration (OSHA)

Handwashing Where We Work

Number of employees	Minimum number of water closets
1 to 15	1
16 to 35	2
36 to 55	3
56 to 80	4
81 to 110	5
111 to 150	6
Over 150	1 additional fixture for each additional 40 employees

OSHA requires employers to provide all workers with sanitary and immediately-available toilet facilities (restrooms). The sanitation standards (29 CFR 1910.141, 29 CFR 1926.51 and 29 CFR 1928.110) are **intended to ensure that workers do not suffer adverse health effects** that can result if toilets are not sanitary and/or are not available when needed.

https://www.osha.gov/SLTC/restrooms_sanitation/

- Compliant
- Accessible
- Safe

Employers must maintain restrooms in a sanitary condition. **Restrooms must provide hot and cold running water or lukewarm water,** hand soap or similar cleansing agent and warm air blowers or individual hand towels (e.g., paper or cloth). Waterless hand cleaner and towels/rags are **not adequate substitutes for soap and water**.

Increasing Penalties for 2020

OSHA's penalty increases for workplace safety and health violations include:

- Willful violation, minimum penalty is $9,639, maximum penalty is $134,937
- Each repeated violation previously cited by the agency: $134,937
- Each serious violation $13,494
  - Each other-than-serious violation, max. $13,494
  - Each failure to correct violation, max. $13,494

https://www.osha.gov/SLTC/restrooms_sanitation/

- Compliant
- Accessible
- Safe

United States Environmental Protection Agency (EPA)

Efficient Hot Water Delivery Systems

Heating water is typically the **second largest use of energy** in a home (after space heating and cooling). Despite its resource intensity, the hot water delivery system is seldom an area of significant focus when constructing a home. As a result, many homes today are built with poor performing, **inefficient** hot water delivery systems that take minutes to deliver hot water to the point of use and **waste** large amounts of **energy** and **water** in the process.

PDF available:
Guide for Efficient Hot Water Delivery Systems

Source: https://www.epa.gov/watersense/guide-efficient-hot-water-delivery-systems

United States Environmental Protection Agency (EPA)

Commercial Buildings

Office buildings, schools, hotels, hospitals, restaurants, and other commercial and institutional facilities use a significant amount of water and energy in their daily operations. Owners and managers of these types of facilities are increasingly aware of the **need to use water more efficiently** to reduce their risk to water shortages and increasing costs. There is a strong business case to be made for water efficiency.

look for WaterSense

Best Management Practices for

Commercial and Institutional Facilities

Although a large portion of our public water supply is used by residential customers, commercial and institutional buildings can account for 17 percent of the municipal water demand in the United States.[1] As significant water users, commercial and institutional facilities have the opportunity to conserve this precious resource and save on their operating costs.

The U.S. Environmental Protection Agency's (EPA's) WaterSense® program created *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities* to help managers and owners of restaurants, office buildings, hotels, schools, hospitals, and other building types—identify and take advantage of water-saving opportunities.

Commercial and Institutional Water Use in the United States by Sector

Source: Dziegielewski, et al. 2000. *Commercial and Institutional End Uses of Water*. American Water Works Association Research Foundation.

THE BUSINESS CASE FOR WATER EFFICIENCY

Over the past 10 years, the costs of water and wastewater services have risen at a rate well above the consumer price index. Facility managers can expect these and other utility costs to continue to increase in order to offset the costs of replacing aging water supply systems.

The business benefits of implementing water-efficiency measures within commercial and institutional facilities include reducing operating costs and creating more sustainable practices. In addition to water costs, facilities will see a decrease in energy bills because of the significant amount of energy associated with heating water. Commercial and institutional facilities can significantly reduce water use through water-efficient fixtures, technologies and techniques.

START SAVING

Implementing water efficiency at work starts with understanding a facility's water-using processes. Developing a water management plan, which includes conducting a facility water assessment, helps managers and owners understand how much water their facilities use and which processes require the most water. An assessment also helps identify potential water-saving opportunities and calculates the payback periods to help prioritize options to reach water savings goals.

Putting Water Efficiency to Work

Upgrading to an ENERGY STAR® qualified commercial dishwasher can save a business an average of $900 per year on its energy bills, in addition to 52,000 gallons of water and more than $200 on water bills.

PHONE (866) WTR-SENS (987-7367) WEBSITE www.epa.gov/watersense EMAIL watersense@epa.gov

EPA EPA-832-F-12-032 November 2012

https://www.epa.gov/sites/production/files/2017-01/documents/ws-commercial-factsheet-general-ci.pdf

Source: https://www.epa.gov/watersense/commercial-buildings

Effective Public Handwashing

Is Dependent Upon
Effective Service Water Heating

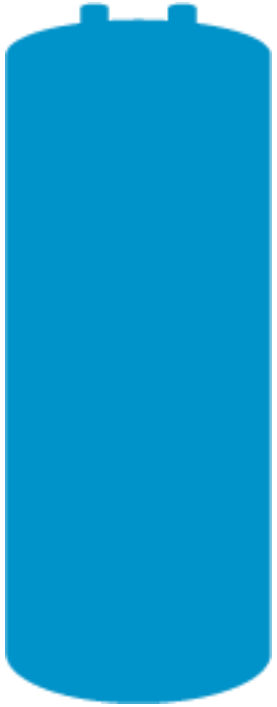
- Efficient
- Compliant
- Accessible
- Safe
- Consistent

Water Heating

Traditional and Non-Traditional Types of Water Heating Technologies

Tank-Type Water Heaters

- Fuel: Gas, oil, or electric
- Construction
  - Enamel lined steel or stainless steel cylinder
  - Control boards, thermostats, electrical components
  - Exterior finishes vary by type and manufacturer
- Heat transfer method
  - Immersed electric element or burner with a flue
- Heats and maintains stored water to set temperature



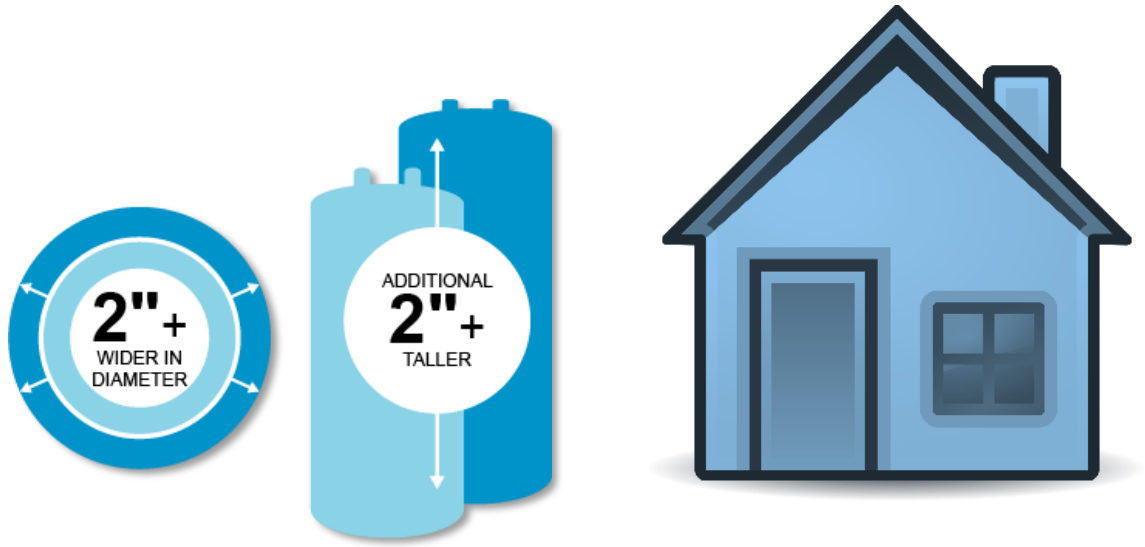
Department of Energy

NAECA 3

- Efficient
- Compliant

- Requires manufacturers to produce more efficient water heater tanks
- Tankless water heaters are unaffected by this regulation

The National Appliance Energy Conservation Act (NAECA) of 1987 is a United States Act of Congress that regulates energy consumption of specific household appliances



Department of Energy

Residential Changes

- Efficient
- Compliant

The Department of Energy changed efficiency minimums for residential gas and electric water heaters.

	Size	Old (EF)	New (EF)
Gas-Fired Storage	≤ 55 gal	0.59	0.62
	> 55 gal	0.55	0.75
Electric Storage	≤ 55 gal	0.9	0.95
	> 55 gal	0.86	1.97
Oil-Fired Storage	> 30 gal	0.53	0.62

Indirect Water Heating

Boilers

- Systems that are used for central heating, or process heat, also serve domestic hot water needs.

Residential Boiler

- Effective option when used with an indirect water heater
- High-cost system that makes sense when hydronic heating is installed

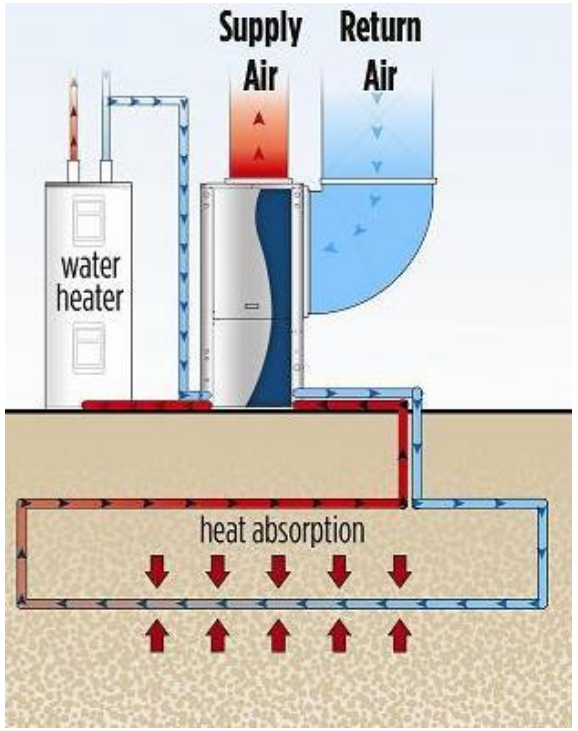
Commercial Boiler

- Large and complex
- Requires costly and extensive maintenance

Geothermal Water Heating

Requires back-up sources

Beneath the earth's surface, the temperature is a constant 50 to 60 °F, a natural and everlasting source of heat. The **geothermal heat** pump takes advantage of this constant heat source by transferring and concentrating the heat to provide: a source of heat energy for space heating, ... a source of heat for domestic **hot water**.

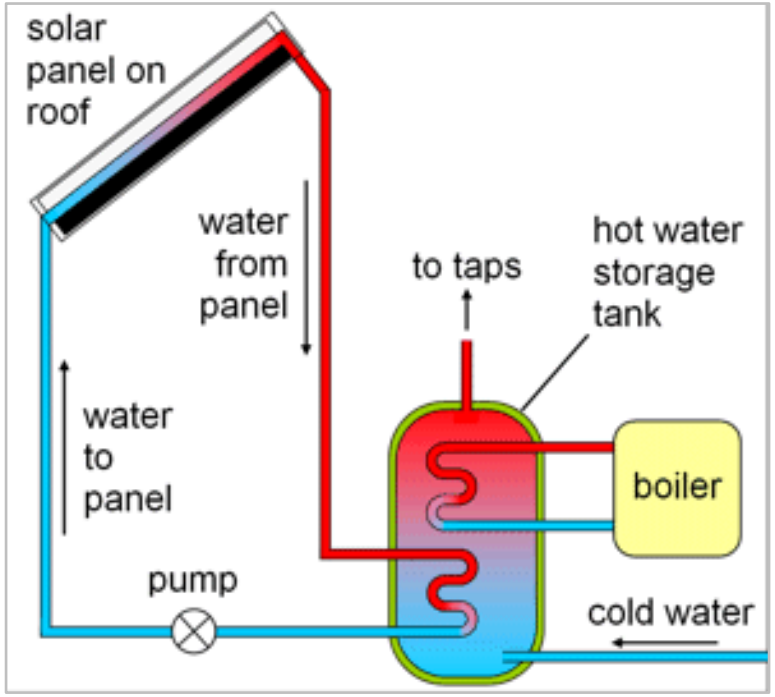


Source: www.energyhomes.org/renewable-technology/howgeoworks.html

Solar Water Heating

Requires back-up sources

Solar thermal energy heats fluid in the solar collectors. Direct systems circulate water through the collectors where it is heated by the sun. Heated water is stored in a tank, sent to a tankless water heater, or used directly. These systems are preferable in climates where it rarely freezes.



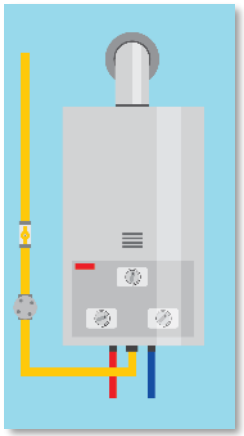
Source: https://www.energystar.gov/products/water_heaters/water_heater_solar/how_it_works

Tankless Water Heating

- Fuel type: electric or gas
- Construction
  - Wetted components consist of brass/copper, stainless steel, or engineered plastic
  - Control boards, relays, various electronic components
  - Exteriors vary by type and manufacturer
- Heat transfer method
  - Electric: heating elements, sheathed or bare wire
  - Gas: heat exchanger with flue
- Flow activated, heating water only on demand

Tankless Electric

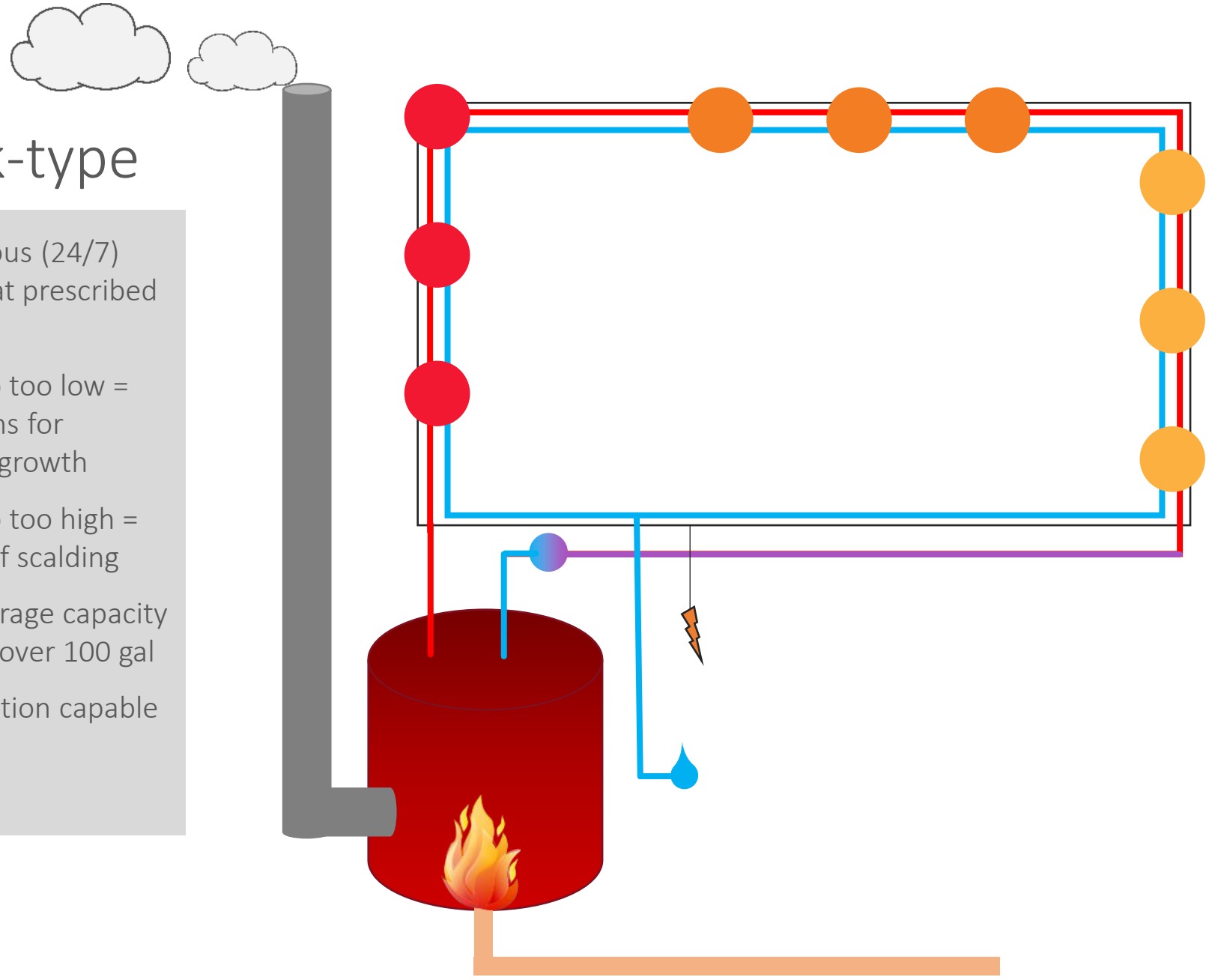
Tankless Gas



Hot Water Delivery Option A

Tank-type

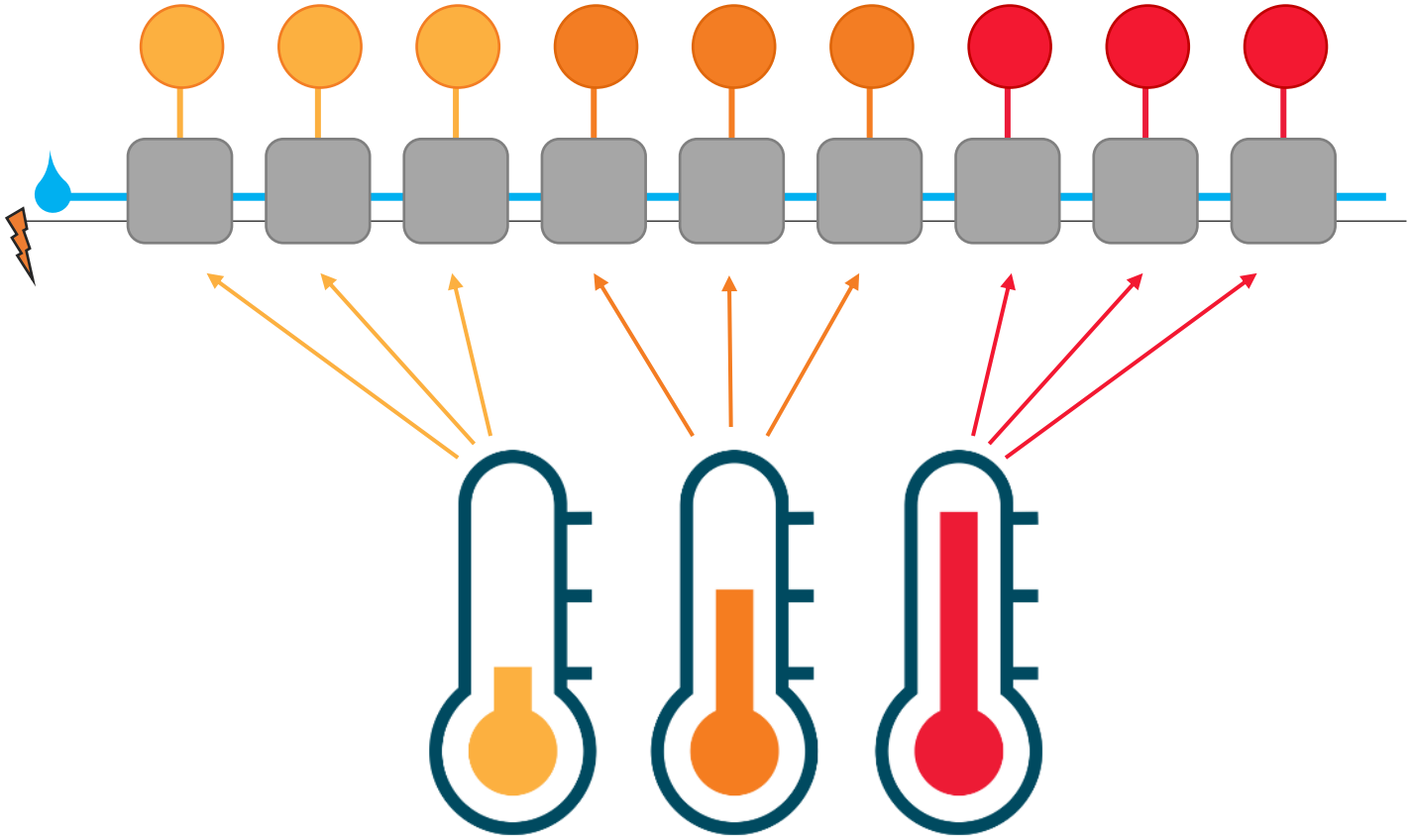
- Continuous (24/7) heating at prescribed temp
- Set temp too low = conditions for bacteria growth
- Set temp too high = danger of scalding
- Huge storage capacity needed, over 100 gal
- Multi-station capable



Hot Water Delivery Option B

Tankless

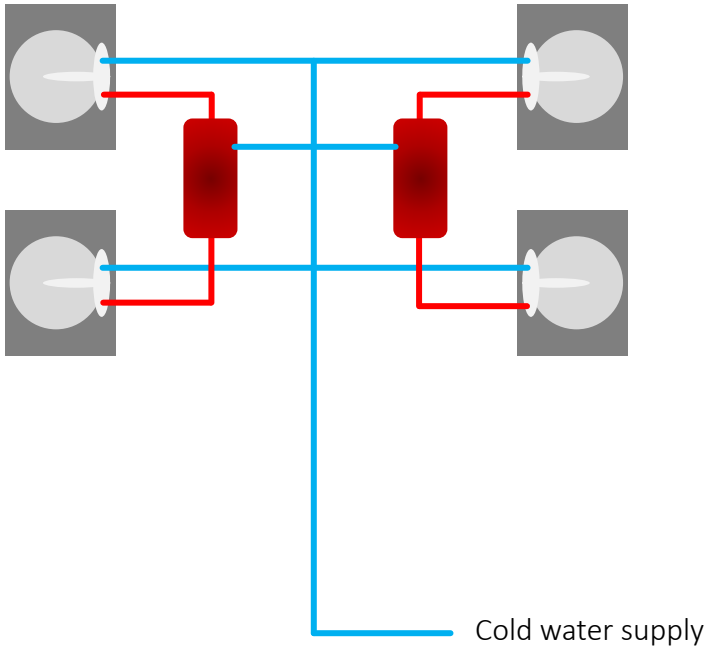
- Tepid water on demand, **precise outlet temperature**
- No water storage
- Saves energy
- Fast and endless
- Point-of-Use capacity is one station
- One water line
- **No venting required for tankless electric**



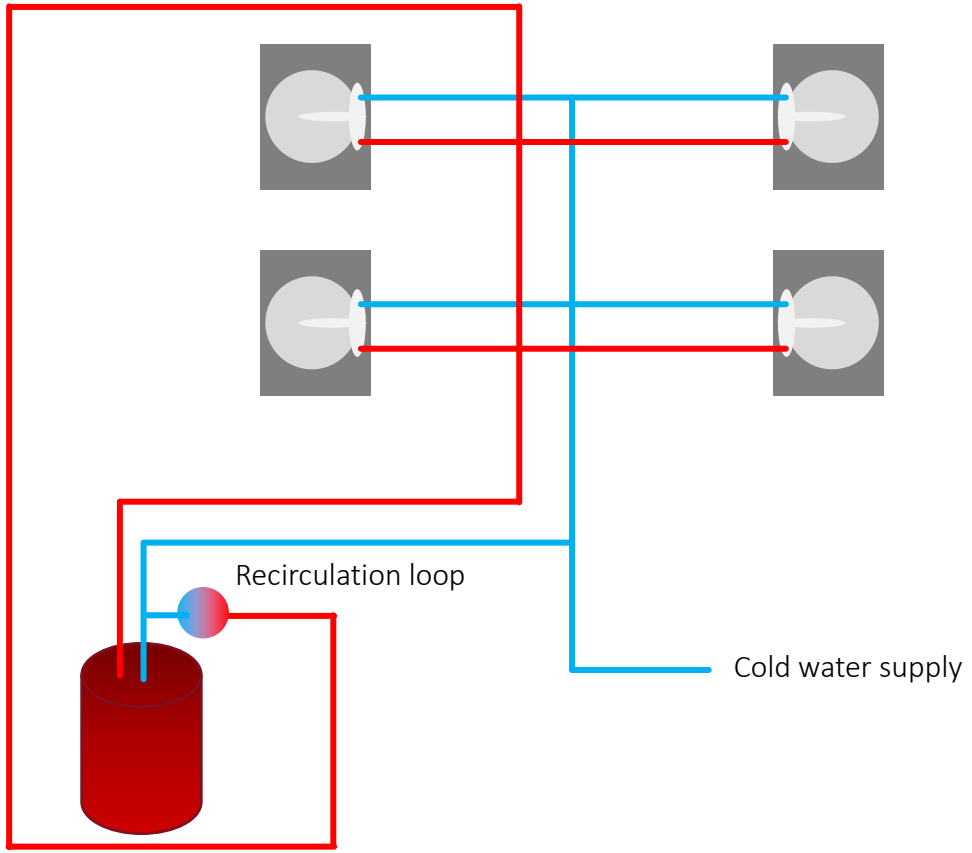
Add for tankless gas

Tankless Electric Ideal for Handwashing

Distributed Point-of-Use



Traditional Design with Recirculation



Benefits of Tankless Electric

A Side-by-Side Comparison

Tankless Electric Water Heater

- Heats water only as needed
- Simplified system designs
- Lower energy cost over time
- No venting required
- Compact, can be wall mounted
- Flexible installation options
- Easy to maintain
- 20 year design life

All others

- Store & heat gallons of water
- Complex integrated systems
- Higher energy cost over time
- Venting required
- Large foot print & buffer space
- Typically require long pipe runs
- Costly maintenance
- 8 – 10 year lifespan

Pros, Cons, and Considerations

	Pros	Cons	Considerations
Tank	Readily available Wide selection	Large and inefficient	**Use the appropriate technology for the application to design a well-balanced system for performance and efficiency.**
Indirect	Multi functional Can handle massive projects	Trade knowledge is a **must** Requires system integration and controls	
Renewable	Free resource Incentives	Subject to resource availability Expensive Needs backup	
Tankless	Compact and efficient Wide selection Readily available	May require a different approach Lack of familiarity	

Retrofit & New Construction Scenarios

Design Considerations

- Available resource
- Product availability
- Water consumption and waste
- Energy consumption and waste
- Reliability
- Performance
- Code & Regulatory Compliance

- Costs associated with:
  - Product
  - Installation
  - Operation
  - Maintenance
  - Ownership

Tankless Electric Water Heaters (TEWH)






Design Benefits – Sustainability

Desired results

- Lower operating costs
- Healthy and comfortable
- Conserve energy and water
- Reduce waste to landfills
- Environmental stewardship

TEWHs that are certified by AHRI to LEED efficiency standards (≥99%), help earn a 2-point credit (12 kW and under)

Tankless Electric Water Heating

Savings

- Space
- Energy
- Water
- Money

Reduces Carbon Footprint

- No venting required
- No green house gas emissions
  - Methane, Nitrous Oxide, Carbon Dioxide, Ozone

- Efficient
- Compliant
- Safe

Advantages

- Water is heated only on demand
- Power is only drawn when needed
- Virtually no stand-by heat loss
- Up to 99% energy efficient
- Compact size
- Easy installation
- No venting
- Longer product life
- Improved hot water delivery
- Safe and reliable
- Low maintenance
- Eliminates unnecessary recirculation

Attributes

- Supports broad range of residential, commercial, and industrial applications
- Delivered flow rate of 0.2 to 40 GPM
- Power range: 1.8 kW to 150 kW
  (6.1 kBTU to 511.8 kBTU)
- Voltage range: 120 V to 600 V
  (Single Phase and Three Phase)
- Temperature range: 60 °F to 180 °F
- Customizable: wide variety of product design and feature options

Misunderstandings vs Reality

Savings with Tankless Electric

Recirculation Supply & Return Loop

5-Year Heat Loop Losses

$32,901.00

Based on calculations at right

	Year 1	Year 2	Year 3	Year 4	Year 5
Loop length (ft) (include supply out and loop return)	500	500	500	500	500
Pipe OD (in) (average supply and return pipe diameters)	1.5	1.5	1.5	1.5	1.5
Pipe ID (in) (average supply and return pipe diameters)	1.48	1.48	1.48	1.48	1.48
Insulation thickness (in)	1	1	1	1	1
Temp of hot water (°F)	140	140	140	140	140
Ambient air temp (°F)	70	70	70	70	70
Thermal conductivity of copper pipe (Btu-ft/hr*ft2*°F)	223	223	223	223	223
Thermal conductivity of Polyurethane insulation (W/ (m*K)	0.03	0.03	0.03	0.03	0.03
Heat Loss Q (kW)	5.37	5.37	5.37	5.37	5.37
Heat Loss Q (Btu/hr)	18,307	18,307	18,307	18,307	18,307
Electricity cost kW-hr ($)	$0.140	$0.140	$0.140	$0.140	$0.140
Time (hr/yr)	8760	8760	8760	8760	8760
Cost to hold loop at temperature for 1 year	$6,580	$6,580	$6,580	$6,580	$6,580
$/ month	$548.34	$548.34	$548.34	$548.34	$548.34

Does Not Draw More Power

- A marathon is 26.2 miles long—no matter if you walk or sprint.
  - A meter will spin the same number of times to generate hot water regardless of technology (tank or tankless).
- Other tankless benefits can outweigh any additional costs associated with increased electrical infrastructure.
- The key is getting in at the design level.
  - Tankless electric water heaters are not an 11th hour product.

NEC 422.10 and 422.11

- Per NEC 422.10 and 422.11 tankless water heaters **are valued at 100%** of the marked rating due to the fact they do **not** fall into a “continuous load” category. Continuous load is described by NEC as a maximum current draw that exceeds 3 hours.

Effective Service Water Heating Supports Effective Handwashing

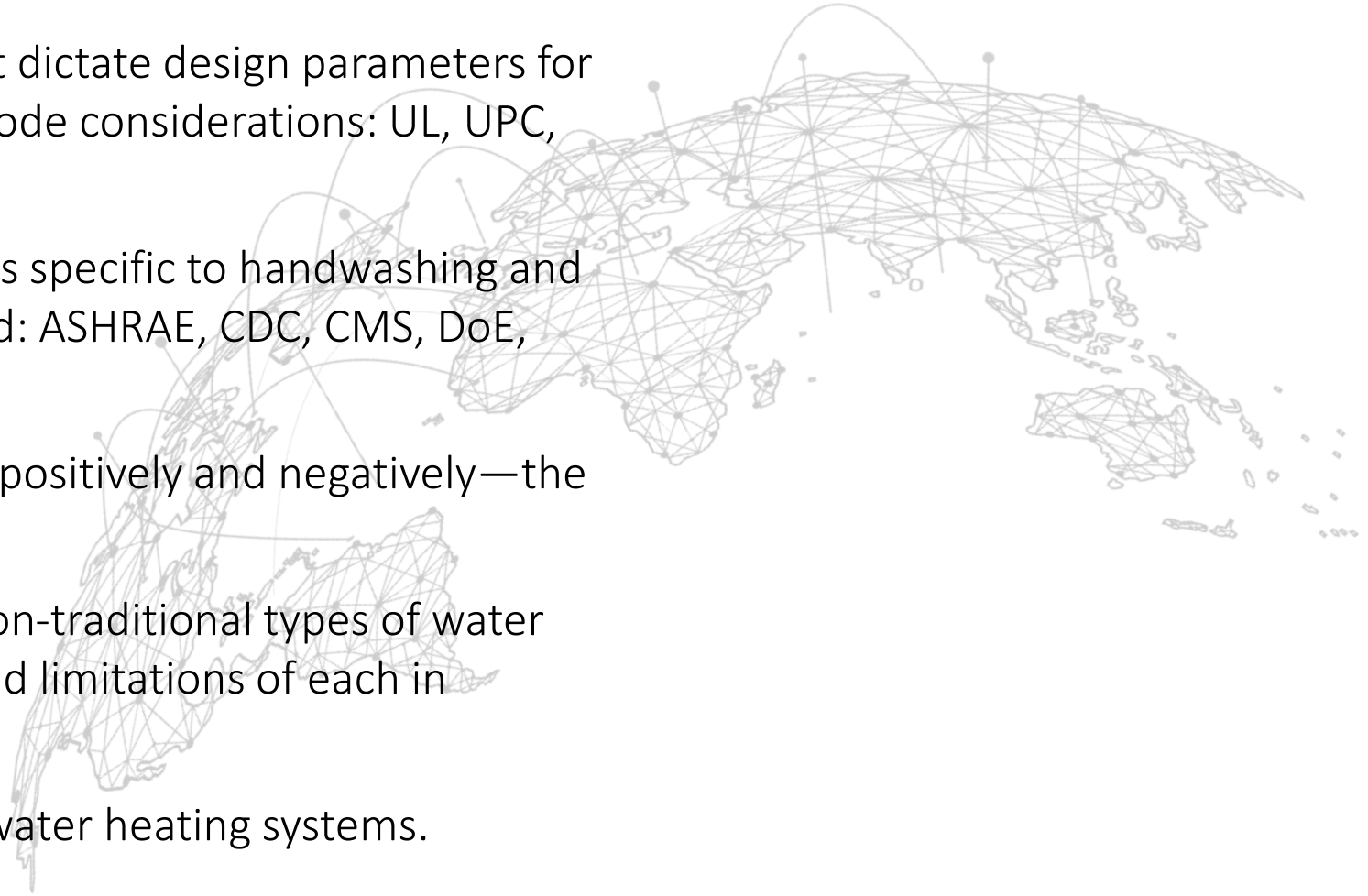
Mitigates environmental impacts

Enables improved, healthy habits



- Efficient
- Compliant
- Accessible
- Safe
- Consistent

Summary



- Service water heating code bodies that dictate design parameters for safe and efficient hot water delivery. Code considerations: UL, UPC, IPC, IECC, ANSI, NEC
- Current public health agency guidelines specific to handwashing and the effects on health. Agencies covered: ASHRAE, CDC, CMS, DoE, EPA, OSHA, WHO
- Water temperature can impact—both positively and negatively—the health efficacy of handwashing.
- Differences between traditional and non-traditional types of water heating technologies, and strengths and limitations of each in handwashing applications.
- Benefits gained with tankless electric water heating systems.

Accessible Handwashing by Design

- Cambridge, Massachusetts
- 150 point-of-use tankless electric water heaters
- Handwashing in every classroom

Project by William Rawn Associates, Architects, Inc., in association with Arrowstreet.

Photography by Robert Benson

What is the best way to heat water?

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ASPE American Society of Plumbing Engineers CEU PROVIDER

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Discussion

A Continuing Education Unit Presented by Eemax®