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Environmental Services Department

Plan Review & Construction Program

Guideline to Sizing Water Heaters, Water Temperature and Potable Water Supply Requirements

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This document serves only as a guide. Please refer to current applicable health, building, plumbing and safety codes.

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PREFACE

I. Purpose

The Plan Review & Construction Program of the Maricopa County Environmental Services Department has developed a uniform guideline and policy for water heater sizing and hot water supply requirements to ensure food/beverage related establishments, and other permitted facilities, operations and premises within Maricopa County are provided with sufficient hot water from an approved source for all operations. The Environmental Services Department wants to help ensure your business is successful, while making Maricopa County a better place to live.

The intent of this guideline is to provide uniform criteria that will assist architects, designers, contractors, owners, and operators in the proper sizing of water heaters to meet the anticipated hot water demands of permitted establishments. When determining hot water supply requirements, sufficient hot water for all operational demands of the permitted establishment shall be taken into account. Each permitted establishment shall be provided with its own dedicated approved water heater.

Hot water is a critical factor in preventing illness in permitted establishments. Hot water or tempered water is required at all sinks. An adequate supply of hot water is a basic requirement essential for proper hand washing, warewashing, equipment cleaning, mopping, and general cleaning duties in an establishment. An insufficient supply of safe hot water will prevent properly cleaning items such as equipment, utensils, and employee's hands.

All hot water generating systems, potable water supply, plumbing, appliances, devices, fixtures, equipment, products, and materials shall meet nationally recognized standards and be certified, or classified by an American National Standards Institute (ANSI) accredited third-party certification agency as complying with the referenced standards, or deemed acceptable by the Department. It is recommended that the manufacturer's specification sheets (commonly referred to as "cut sheets") be consulted for hot water supply capacity requirements and shall be provided to the Department for review upon request.

The hot water supply shall be sufficient to satisfy the continuous and peak hot water demands of food related establishments, and other permitted facilities (i.e. school grounds, pet shops, groomers, and residence accommodations) in Maricopa County as determined by the Plan Review & Construction Program. The proper selection and installation of appropriately sized water heaters will facilitate this goal.

The Department encourages the selection and installation of thermally efficient water heaters as developed by the Federal Government Energy Guide label, and the U.S. Environmental Protection Agency and Department of Energy's Energy Star® program which measures the energy factor - the overall annual efficiency of the water heater, taking into consideration loss of energy due to combustion, radiation, convection, and the conduction of heat from the unit listed by a nationally recognized testing laboratory.

Mobile Food Establishments have specific hot water supply requirements, and shall be provided with potable hot water for food preparation, utensil washing, sanitization, and hand washing. Please contact the Department's Mobile Food/Special Events Program for additional information regarding specific hot water supply and sizing requirements for Mobile Food Establishments.

The Plan Review & Construction Program is here to assist you. If you have any questions or require assistance please contact the Maricopa County Environmental Services Department's Plan Review & Construction Program at 602-506-6980 or by e-mail at esd.maricopa.gov.

II. Applicable Code

All plumbing systems shall be designed, constructed, installed, operated, maintained and repaired in accordance to law and applicable codes. Conformance with the following requirements or similar requirements shall be adhered to for the determination of Maricopa County Environmental Health Code compliance with health and plumbing codes.

As of December 10, 2014, the Maricopa County Environmental Services Department incorporated by reference the U.S. Food and Drug Administration 2013 Food Code (2013 FDA Code). For purposes of this guideline, references to "Regulatory Authority" in the U.S. Food and Drug Administration 2013 Food Code mean the Maricopa County Environmental Services Department.

The 2009 International Plumbing Code (IPC), as adopted by the Maricopa County Board of Supervisors on August 18, 2010 and as amended by Section 301 of Chapter 3 of the Maricopa County Planning & Development Department's Local Additions & Addenda dated October 2010, shall be adhered to for code compliance.

Establishments located in an unincorporated area of Maricopa County shall adhere to the 2012 International Plumbing Code (IPC), as adopted by the Maricopa County Board of Supervisors on August 7, 2013 and as amended by Section 301 of Chapter 3 of the Maricopa County Planning & Development Department's Local Additions & Addenda, for code compliance.

A. Definitions

- **Appliance**: See "Plumbing Appliance"
- **Backflow**: Pressure created by any means in the water distribution system, which by being in excess of the pressure in the water supply mains causes a potential backflow condition.
- **Booster Heater**: A tankless water heater designed and intended to raise the temperature of hot water to a higher temperature for a specific purpose, such as for the sanitizing rinse of a high temperature automatic warewashing machine.
- **British Thermal Unit (Btu)**: The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.
- **Cold Water**: Potable water at a temperature less than 85ºF.
- **Cross connection**: Any physical connection or arrangement between two otherwise separate piping systems, one of which contains potable water and the other either water of unknown or questionable safety or steam, gas or chemical, whereby there exists the possibility for flow from one system to the other, with the direction of flow depending on the pressure differential between the two systems. See "backflow".
- **Draw Rate**: The rate at which hot water is drawn from a water heating system, in gallons per minute (gpm), and restricted to delivery points.
- **Drinking Water**: Water that meets criteria as specified in 40 CFR, traditionally known as "potable water" and includes the term "water" except where the term used connotes that the water is not potable, such as "boiler water," "mop water," "rainwater," "wastewater," and "nondrinking" water.
- **Energy Factor (EF)**: A measure of overall water heater efficiency. It is the ratio of useful energy output from the water heater to the total amount of energy delivered to the water heater.
- **Faucet**: A valve end of a water pipe through which water is drawn from or held within the pipe.
- **First Hour Rating (FHR)**: Also referred to as the first hour output of a conventional storage water heater. The calculated maximum volume of hot water in gallons that a storage water heater can deliver in the first hour period with the water heater fully heated. It is the performance capability/delivery figure that estimates the peak demand, in gph, of how much hot water the unit will deliver during the first hour after it begins using hot water. The rating is reached by combining the water heater's storage capacity (fully heated usable hot water stored in the tank) plus how many gallons of usable hot water the unit can generate (recovery capability) during one hour of operation.

Essentially the first hour rating or output figure is the based on how many gallons of hot water can be delivered in the first hour of operation, and is determined by the tank's capacity and recovery rate. Water heaters are typically labeled with this first hour output rating in gallons per hour (gph).

- **Fixture**: See "Plumbing Fixture".
- **Flow Rate (Volume Flow Rate):** The volume of fluid (e.g. water) which passes through a specified surface per unit of time.
- **Food Preparation Sink**: A separate culinary sink in establishments that are engaged in activities such as washing, rinsing, soaking, thawing, trimming, or similar preparation of foods, and shall be located within the food preparation area. Sinks used for the preparation of food shall not be used for any other purpose.
- **Gallons per Hour (gph)**: The amount of hot water, in gallons, that is used each hour by the plumbing fixtures and equipment, such as warewashing machines, or the volume of water in gallons that a storage water heater can adequately supply within an hour while maintaining a nominal temperature rise during steady state operation.
- **Gallons per Minute (gpm)**: The amount of hot water or draw rate, in gallons, that is used each minute by plumbing fixtures and equipment. Restricted by the flow capacity of a tankless water heater, or the volume of water in gallons that a tankless water heater can adequately supply within a minute while maintaining a nominal temperature rise during steady state operation.
- **Garbage Can Washer**: Defined as a fixture, appliance, device, unit, or similar system designed and plumbed with water under pressure to wash garbage cans.
- **Ground Water Temperature**: The incoming cold water inlet temperature of the local approved potable water supply (municipal or well). For sizing purposes the incoming water temperature is estimated for the average annual year in Maricopa County. The ground water temperature of tap water varies throughout Maricopa County depending upon the location, elevation, and time of year. In order to properly size a water heater, the Department has determined based upon available ground water temperature map data that for the purposes of this guideline an average annual incoming potable tap water temperature of 60°F shall be used. Note: 60°F is also the average year-round ground water temperature in most of the Southwest, Southern California, the Southwest and Gulf states. Throughout most of the United States the average cold water temperature during the coldest months is approximately 40°F.
- **Heat Trace (Electrical heat tape/cable or electrical heat tracing)**: Means a heating system method with an externally applied heat source, typically a heating cable that traces the surface of an object (i.e. copper water supply line) to be heated, in order to maintain the temperature of pipes, pipeline equipment, drain lines and vessels. Heat trace is commonly used in the form of an electrical heating element/cable run in physical contact along the length of pipe. In insulated pipe work systems the pipe must be covered with thermal insulation to retain heat losses from the pipe. Heat generated by the element then maintains the temperature of the pipe. Heat trace may be used to protect pipes from freezing, or to maintain process temperatures for piping that must transport substances that solidify at ambient temperatures. Electric heat trace elements/cables are typically utilized on walk-in freezer drain lines to prevent them from freezing. Heating the layer between insulation and pipes in an insulated pipe-work system is used to reduce the viscosity and thereby facilitate the flow of liquid.
- **Hot Water**: Potable water at a temperature equal to or greater than 110°F.
- **Input**: Is the amount of gas or electricity used per hour to heat water in the storage tank. Input is expressed in Btu's for gas-fired units or Watts for electric units. Converts Btu or Watt input into gallons heated per hour. For example, a 40,000 Btu gas-fired water heater heats, or recovers approximately 41-gallons in one hour. For water heaters, higher input means the water heater can heat more water faster when needed.
- **Instantaneous Water Heater:** See "Tankless Water Heater".
- **Kilowatt (kW)**: A unit of electric power equal to 1,000 Watts.

- **Lukewarm Water**: See Tepid Water.
- **Metered Faucet**: Also known as metering or self-closing faucet, a faucet containing a valve that automatically closes upon deactivation of the opening means. A metered faucet shall provide a flow of water for at least 15 seconds without the need to reactivate the faucet.
- **Peak Demand**: This peak demand or period is defined as the time when the highest amount of hot water is being used simultaneously or when the heating system experiences it greatest demand or draw. The peak demand or period can be dramatically different in various types of permitted facilities.
- **Peak Load**: Refers to the maximum amount of hot water over a given time period (usually a 1-3 hour time period) when sizing storage capacity. It is not to be confused with the sizing of a peak demand.
- **Plumbing Appliance**: Water connected or drain-connected devices intended to perform a special function. These devices have their operation or control dependent on one or more energized components, such as motors, controls, or heating elements. Such devices are manually adjusted or controlled by the owner or operator, or are operated automatically through one or more of the following actions: a time cycle, a temperature range, a pressure range, a measure of volume or weight. Examples of plumbing appliances include warewashing machines, clothes washers, garbage disposals, water softeners, water purifiers, and water heaters.
- **Plumbing Fixture**: A fixture, receptacle, or device that is either permanently or temporarily connected to a water supply system or discharges to a drainage system or both. Such receptacles or devices require a supply of water; or discharge liquid waste or liquid-borne solid waste; or require a supply of water and discharge waste to a drainage system. Sinks, waterless urinals, and floor drains are defined as plumbing fixtures.
- **Point-of-Use**: The final outlet of the water supply system just prior to discharge for use.
- **Potable Water**: See Drinking Water. Water free from impurities present in amounts sufficient to cause disease or harmful physiological effects and conforming to the bacteriological and chemical quality requirements of the Public Health Service Drinking Water Standards or the regulations of the public health authority having jurisdiction.
- **Premises**: Means - (1)The physical facility, its contents, and the contiguous land or property under the control of the permit holder; or (2) The physical facility, its contents, and the land or property not described in subparagraph (1) of this definition if its facilities and contents are under the control of the permit holder and may impact food establishment personnel, facilities, or operations, and a food establishment is only one component of a larger operation such as a health care facility, hotel, motel, school, recreational camp, or prison.
- **Recovery Rate**: The capacity of a storage water heater (in gallons) to produce hot water in (1) hour. Note: A 100% recovery rate is required. It is determined by the manufacturer's listed recovery rate in conjunction with the 60ºF rise in temperature. Also, it is a component of the First Hour Rating.
- **Rise**: The temperature (Fahrenheit/Celsius) of water as it leaves the water heater at the "set point" temperature minus the temperature of the cold water (ground water) entering the water heater. Note: The required rise in temperature shall be 60ºF when calculating the hot water recovery rate in Maricopa County. Therefore, to achieve a temperature of 120ºF, the required rise in temperature shall be 60ºF when calculating the hot water recovery rate.
  Rise = (Set point Temperature) – (Ground Water Temperature).
- **Service Sink**: A properly plumbed sink, basin or receptor intended for custodial use that is capable of being used to fill and empty a janitorial mop bucket. Service sinks are also used for cleaning of mops, or similar wet floor cleaning tools, and for the disposal of mop water and similar liquid waste. Included are mop basins, mop sinks, laundry sinks, utility sinks, janitorial sinks, curbed cleaning facility/station, and similar fixtures. Any of the sinks listed in the definition of a "service sink" may be approved to be used as a service sink by the Department. Toilets and urinals are not approved

janitorial receptacles. A service sink may not be used for employee hand washing. Service sinks are required in all occupancies permitted by this Department.

- **Set Point Temperature**: The temperature that the water heater will be set. The water heater shall be set at the temperature required to meet the hot water demand in an establishment. If varying hot water temperatures are required, the highest required temperature shall be used.
- **Storage Water Heater**: A water heater that incorporates a thermostat, a storage tank, and a burner or heating elements, to heat and maintain the water within the tank at a specific temperature. A storage water heater is factored for the total hot water storage capacity in gallons, and in gallons per hour (gph) for the initial supply and recovery rates.
- **Tankless Water Heater**: An on-demand, instantaneous water heater that generates hot water on demand which initiate heating based on sensing water flow and deliver water at a controlled temperature, and can deliver a supply of hot water without the use of a storage tank. When a hot water faucet is turned on, cold water travels via a pipe through a tankless water heater. Electric units use an electric element to heat the water. In a gas-fired tankless water heater a gas burner heats the water. It avoids the standby heat loss associated with storage water heaters. Tankless water heaters are factored for a hot water supply rate in gallons per minute (gpm).
- **Tempered Water**: Potable water supplied from an approved source through a properly regulated mixing valve/limiting device that conforms to ASSE 1070, and shall limit the tempered water to a maximum of 110°F. Tempered water in food-related establishments shall be 100°F to 110°F. Tempered water in all other permitted non-food establishments may be 85°F to 110°F. The recommended temperature for tempered water hand sink faucets is 100°F to 105°F. Water at a temperature of 85°F to 110°F water may be provided at tempered water hose bibs in non-food establishments. A water temperature of 100°F is required at tempered water hose bibs in food-related establishments. 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 B125.3
- **Tepid Water**: Lukewarm water that it is neither hot nor cold to the touch. The American National Standards Institute (ANSI) Z358.1-2009 Emergency Eyewash and Shower Equipment Standard, stipulates that tepid water have a suitable temperature from 60°F to 100°F. Tepid water is required in emergency showers and eyewash stations because it will neither scald nor freeze a victim of chemical burns. Temperatures that exceed 100°F can enhance chemical interaction with the eyes and skin. Flushing fluid temperatures below 60°F can cause hypothermic shock.
- **Thermal Operating Efficiency**: The measure of the overall efficiency of the water heater, taking into consideration loss of energy due to combustion, radiation, convection and conduction of heat from the unit. For gas-fired water heaters the thermal operating efficiency will be assumed to be 70% energy factor (EF), unless otherwise listed by NSF-International or other nationally recognized testing laboratories.
- **Warewashing Machine**: Refers to any approved commercial spray-type warewashing machine, dish machine, dishwasher, glass-washer, conveyor machine, pot-washer, sanitizer machine, power-soaker at a dish sink, or similar machines that are used for the cleaning and sanitizing of utensils and food-contact surfaces of equipment in permitted facilities. The warewashing machines shall meet ANSI/NSF Standard #3 requirements.
- **Warm Water**: See Tempered Water.
- **Water Heater**: Any heating appliance or equipment that heats potable water and supplies such water to the potable hot water distribution system.

III. General Water Heater and Water Supply Requirements

Permitted establishments with properly sized water heaters shall be capable of complying with these requirements for providing an adequate hot water supply as required by the Maricopa County Environmental Health Code.

Hot water shall be sufficient to meet the specific hot water peak demands and requirements of food-related establishments, and as stated in adopted codes and in this guidance document.

The installation of commercial water heaters is strongly recommended. Standard domestic/residential type water heaters may receive final approval if the units meet current requirements in this guidance document. Please note that residential water heaters are typically sized on the number of occupants and peak hour hot water demand. Multiple water heaters or the installation of an approved commercial boiler unit may be necessary to meet the overall hot water demands of an establishment.

A continuous supply of adequate hot water, as stated in adopted codes, shall be provided in other permitted facilities (i.e. school grounds, pet shops, groomers, and residence accommodations). The installation of approved boilers or point-of-use water heaters may be required to ensure permitted facilities are provided with sufficient hot water for all operations. Example - A separate point-of-use water heater of adequate size and capacity may be required to exclusively supply hot water to a restroom lavatory and service sink in a pet shop/ grooming facilities, in addition to the primary water heater that supplies hot water to the pet grooming/ wash system(s).

It is recommended that schools, residence accommodations, assisted living facilities, grocery stores, big-box establishments, grocery store warehouses, places of worship, athletic clubs, and other larger establishments provide a separate hot water system for food service operations, rather than installing one general hot water system to supply all hot water demands. An individual point-of-use hot water system can ensure a calculated and consistent supply of hot water to food service operations due to the fluctuating demands created by showers, baths, laundries, and other fixtures which could adversely affect the supply requirements in food-related facilities. Establishments that propose a single or sole source hot water supply system shall provide an accurately sized system to meet the total fixture/appliance demand.

Each establishment, permit holder, and permitted premises shall have its own properly sized dedicated hot water supply source as determined and approved by the Department. A "shared facility" food establishment, as determined by the Department that shares food preparation, food storage, and/or warewashing facilities with three (3) or more permittees under different ownership may receive approval for a single water heater source, if properly sized.

The following critical factors shall be taken into consideration when designing and/or determining the hot water requirements of an establishment:

1. Plumbing Appliance and Fixture Count: What are the hot water fixture demands of the facility?
2. Application Type: Each separate permit type may have very different requirements.
3. Special Use Equipment/Appliance/Fixtures: Specialized equipment/ appliances/ fixtures may have unusual or metered water demands.

To properly size a water heater in Maricopa County the required temperature rise shall be 60ºF when calculating hot water recovery.

Correctly sized water heaters of adequate capacity and recovery shall be provided which are capable of furnishing a continuous supply of hot water, at a thermostat set-point of at least 120ºF, to all hand sinks, dish/utensil sinks, mechanical warewashing machines, rinse sinks, service sinks, garbage can washers, shower heads, similar equipment, and other plumbing fixtures that utilize hot water, within 45-seconds at all times.

The maximum developed length of piping between a hot water or tempered water supply source and all fixtures or appliances served by the supply source shall not exceed 60-feet for incorporated areas, or 50-feet in unincorporated areas of Maricopa County. The installation of a recirculation pump may be required, in order to ensure that water reaches the sink fixture or appliance at a temperature of at least 110ºF or required temperature within 45-seconds.

It is recommended that circulating hot water systems be insulated in accordance with the International Energy Conservation Code® (IECC). The IECC code requirement for insulating hot water piping in automatic temperature maintenance systems is a provision of the 2012 IPC. Hot water piping insulation, heat traps, and water distribution piping in bundles, hot water system controls, recirculation pumps, thermal expansion controls, pressure-reducing valves, water heater thermostats, and water-temperature limiting means shall be installed in accordance with applicable code requirements.

The installation of a heat trace/self-regulating tape system to supply tempered water to long lengths of piping run is strongly discouraged. Heat trace may be installed if necessary to reduce stagnation and the growth of microorganisms in the water.

The installation and use of heat trace systems require final on-site evaluation and approval. Where practical, the Department recommends installing separate point-of-use water heaters for remote fixtures or appliances, such as lavatories in school restrooms. The installation of timers on water heaters is not recommended.

The hourly hot water demand for the permitted establishment, in gph, is calculated by adding together the estimated hot water demands for all sinks and other equipment that utilizes hot water. The approximate hot water demand for sinks and other plumbing appliances/fixtures, and other equipment are shown in Table-1 page 17.

Proper sizing of water heaters in permitted establishments requires an estimation of peak demand. Peak demand is defined as the highest amount of hot water being used simultaneously. Sizing methods factor the capacity of the hot water source, from either conventional storage tank or tankless water heaters, to the needs of the establishment. Key criterion for sizing water heaters are:

Conventional storage-tank water heater: Hot water storage capacity and recovery rate, in gph.

Tankless-water heater: Hot water flow rate, in gpm.

All properly sized conventional storage-tank water heaters, including related equipment, appliances, tempering devices, recirculation pumps, mixing valves, etc. require final on-site evaluation and approval prior to use in permitted establishments.

All other heat generating equipment, including tankless water heaters, heat pumps that capture warmth from the air, heat reclaim/heat recovery, heat storage systems, tankless coil and indirect water heaters, indirect integrated or combination heating systems, geothermal heat pumps, solar energy utilization, hybrid or alternative heating systems require prior evaluation, and are approved only on a case-by-case basis.

Hot water shall be on the left side, cold water on the right side, and properly marked at all faucets, per requirement. Fixture fittings, faucets, and diverters shall be installed and adjusted so that the flow of hot water from the fittings corresponds to the left-hand side of the fixture fitting, except shower and tub/shower mixing valves conforming to American Society of Sanitary Engineering - ASSE 1016 or Canadian Standards Association - CSA B125 where the flow of hot water corresponds to the markings on the device.

Hot and cold water shall be available under adequate pressure, regardless of the supply system. The distribution of water to the facility must be protected and operated according to law. Adequate pressure is to be maintained at all fixtures during peak demand including the capacity to provide hot water at peak hot water demand. Inadequate water pressure could lead to situations that place the public health at risk. For

example, inadequate pressure could result in improper hand washing or equipment operation. Sufficient water pressure ensures that equipment such as mechanical warewashing equipment operates according to manufacturer's specifications.

Maricopa County Environmental Health Code requires that all plumbing connections drain to an approved sanitary drainage system or approved grey water drainage system.

Heat Trace
The installation of a heat trace/self-regulating tape systems to supply tempered water to long lengths of piping run is strongly discouraged. However, heat trace may be installed if necessary to reduce stagnation and the growth of microorganisms in the water.

The installation and use of heat trace systems require final on-site evaluation and approval. Where practical, the Department recommends installing separate point-of-use water heaters for remote fixtures or appliances, such as lavatories in school restrooms. The installation of timers on water heaters is not recommended.

Heat Reclaim Systems
Heat reclaim systems recover heat energy from refrigeration equipment within an establishment and use this energy to generate hot water. A heat reclaim system includes a storage tank and may be used to preheat the water entering a water heater. While a heat reclaim unit will increase a water heater's recovery capacity, it's capability to generate hot water varies with energy input it receives. Therefore, only the storage capacity of the storage tank plus any recovery capacity of any heating elements can be used in determining supply requirements of the hot water system. Typically, heat reclaim systems are utilized in conjunction with conventional storage tank water heaters.

Solar Energy Water Heater Systems
Solar energy water heaters include a collector and storage tank, and utilize the sun's thermal energy to heat water using one of the four basic types of solar water heating systems; forced circulation (both direct and indirect systems), integrated collector and storage, thermo-siphon, or self-pumped. Solar energy water heater systems used for heating potable water or using an independent medium for heating potable water shall comply with the applicable requirements of the health code and this guideline. The use of solar energy shall not compromise the requirements of cross-connection/backflow prevention or protection of the potable water supply system required by applicable codes. All construction, installation, alterations, and repair of solar energy systems and appliances intended to utilize solar energy for hot water heating shall be in accordance with all applicable codes. It is recommended that solar water heater systems match published performance results provided by the Solar Rating & Certification Corporation™ (SRCC), a non-profit organization whose primary purpose is to provide performance ratings, certifications, and standards for solar thermal products by providing guidance to consumers, industry, and government. The utilization of a solar water heater system in an approved permitted establishment is approved only on a case-by-case basis.

A. Specific Hot Water Supply Requirements and Additional Requirements
In permitted facilities, hot water or tempered water shall be supplied for hand washing, warewashing, culinary purposes, cleaning, bathing, laundry, building maintenance purposes, etc.
All equipment shall meet ANSI standards, be certified and verified by the Department through an on-site field evaluation. The Department accepts NSF, or similar sanitation marks (i.e. UL-EPH (Underwriters Laboratories – Environmental Public Health), ETL (Electrical Testing Laboratory) Sanitation, or CSA Sanitation) from an accredited certification program, or deemed acceptable by the Department.

1. **Hand Washing**
   Hot water is more effective than cold water in removing soils encountered in facilities. An adequate flow of warm water will cause soap to lather and aid in flushing soil quickly from hands and equipment. ASTM International (America Society for Testing and Materials International) standards for testing the efficacy of hand washing formulations indicate that a water temperature of 100°F to 108°F is the most effective temperature range for proper hand washing. Temperatures are measured from the faucet.

   Hot water for hand washing shall be at least 110ºF supplied through a mixing valve or combination faucet in food-related establishments. Tempered water in food-related establishments shall be 100ºF to 110ºF.

   In non-food establishments, hot water or tempered water (85ºF to 110ºF) under pressure is required at all hand wash sinks, service sinks, garbage can washer, and showerheads, etc.

   Employees shall clean their hands and exposed portions of their arms, including surrogate prosthetic devices for hands or arms for at least 20 seconds, using an approved hand cleanser, following cleaning procedures and rinse under clean, running warm/tempered water.

2. **Manual Warewashing**
   The temperature of the wash solution in manual warewashing equipment (3-compartment sink) shall be maintained at not less than 110ºF with liquid detergent. If hot water is used for sanitization in manual warewashing operations, the sanitizing compartment of the sink shall be designed with an integral heating device that is capable of maintaining water at a temperature not less than 171ºF.

3. **Automatic/Mechanical Warewashing Equipment**
   Effective sanitization depends on warewashing being conducted within certain parameters. Time is a parameter applicable to both chemical and hot water sanitization. The lengths of time hot water or chemicals are in contact with utensils or food-contact surfaces must be sufficient to destroy pathogens that may remain on the surfaces after cleaning. Other parameters, such as rinse pressure, temperature, and chemical concentration are used in combination with time to achieve proper sanitization. The actual temperatures and rinse pressure shall be consistent with the warewashing machine manufacturer's operating instructions and within limits specified in code. For more specific temperature and operating requirements, see section IX.

B. General Water Heater Installation Requirements

Regardless of the water supply system, the distribution of the fresh water supply to the facility must be protected and operated according to law. Adequate pressure is to be maintained at all fixtures during peak demand, including the capacity to provide sufficient hot water at peak hot water demand periods.

Inadequate water pressure in establishments could lead to situations that place public health at risk. For example, inadequate pressure could result in improper hand washing or equipment operation. Sufficient water pressure ensures that equipment such as mechanical warewashers operate according to manufacturer's specifications.

An inadequate flow or temperature of water may lead to poor hand washing practices by employees. A mixing valve or combination faucet may be necessary to provide properly tempered water for hand washing.

Design and installation considerations shall be made when locating water heaters and hot water storage tanks. Where feasible, it is recommended that water heaters be located in areas that are protected,

readily accessible, separate from food/ beverage, utensil handling, work and traffic areas. It is highly recommend that gas-fired units be installed in areas free of contamination (i.e. grease, flour).

Water heaters shall be installed in accordance with the manufacturer's installation requirements. Water heater manufacturers recommend that water heaters with combustion air intakes be installed away from vent hoods, chemical dish machines, and exhaust hoods of other appliances. The exhaust from these appliances may be highly corrosive and cause premature failure of water heater components. Clean combustion air shall be provided to the water heaters in order to maintain performance. It is highly encouraged that descaling and routine maintenance be performed as recommended by the manufacturer. Consider installing water filters and/or softeners.

Install the water heater at the "set point" temperature required to meet the hot water demand of the establishment. If multiple different hot water temperatures are required, the highest required temperature shall be used.

Easily readable external thermostats are recommended to be installed at water heater units. Due to the hard water quality in Maricopa County it is highly recommended that a water softener or water filters be installed to extend the life of a water heater unit.

A water heater unit shall be provided with an easily accessible and readable data plate affixed to the unit by the manufacturer that indicates the design, and operation specifications including the storage capacity and recovery rate.

Water heaters equipped with small storage tanks, but have large recovery capabilities may appear sufficient to meet total fixture demand of an establishment. However, in some cases these water heaters have not been capable of providing sufficient hot water for immediate demand. When multiple water heaters are used to provide a single source of hot water supply, it is recommended the units be plumbed in parallel to provide maximum hot water output. When calculating supply capacities for water heaters that are plumbed in series, only the first unit's recovery capacity may be added to the hot water system's total storage capacity for sizing requirements.

Local building codes also regulate the installation of water heaters and prohibit water heaters from being installed in certain areas. All water heaters, hot water storage tanks, and water heater systems regardless of type require final on-site installation approval, and shall be in compliance with all local building, fire, plumbing, and cross-connection code requirements.

A plan review permit may not be required to replace an existing water heater provided that it of the same capacity or larger and work is done in accordance with manufacturer's specifications and local codes.

Water heaters and hot water storage tanks shall be installed in one of the following manners:

1. Directly on the floor protected from high moisture areas.
2. In a galvanized steel pan of not less than No. 24 gauge, where water leakage from the tank will cause damage, or other pans approved for such use.
3. On 6-inch high, durable and easily cleanable legs.
4. On a coved curb base. Properly seal all gaps and cracks to a waterproof finish.
5. On a properly installed and finished pedestal.
6. In an easily accessible location by a ladder above a suspended ceiling.
7. In an easily accessible water heater closet, mezzanine, fire-riser room, or mechanical room.
8. Alternative installation methods for water heaters may be acceptable when approved by the local building authority, such as installing a water heater outside or on a roof. Roof mounted water heaters shall be easily accessible by a ladder.

9. All finishes shall meet current Department requirements.
10. All gaps, cracks, penetrations shall be properly sealed.
11. All openings and vents to the exterior shall be properly protected.
12. When multiple water heaters are provided and connected, they shall be installed in parallel, and not in a series.
13. Temperature and pressure relief (T&P) valves, discharge piping, required pans and drainage lines shall be provided per applicable codes.
14. Note: A common mistake made with electric water heaters is combining the upper and bottom heating elements in an attempt to increase hot water output. For example, the ordering and installing of a water heater with an upper element of 4500 watts, a bottom element of 4500 watts, and a total connected (or maximum) wattage of 4500 watts. On such a water heater only one element is operating at any one time. Many individuals do not recognize the total connected wattage and incorrectly assume that because each of the elements is 4500 watts their heater has an input rating of 9000 watts. Water heater manufacturers have specific procedures for rewiring an electric water heater so that the upper and lower elements are operating simultaneously. Some manufacturers only permit rewiring in the factory; field modifications will normally void warranties and any listings that the unit comes with. The Department does not recommend the rewiring of water heaters. Any proposal for field modifying a water heater by rewiring requires prior evaluation and final on-site approval. If approval has been granted to field modify a unit, appropriate documentation shall be provided and the data plate on an approved field modified unit shall be changed to reflect the total connected wattage rating with both elements operating simultaneously.

In addition, the following are specific requirements that shall be considered when properly sizing and locating water heaters, appliances, and fixtures:

1. Restrooms shall be located within 300-feet in covered malls, 500-feet in occupancies other than covered malls.
2. The service sink (i.e. mop sink) shall be conveniently located within 300-feet and readily accessible.
3. Hand wash sinks shall be centrally located, visible, and directly accessible within 25-feet of all food and beverage work stations/areas including all bars.

C. Backflow Prevention

Water heaters, boilers, hot water generating equipment, warewashing machines, warewashing equipment, and similar appliances or fixtures connected to a water supply may require the installation of approved backflow protection through either an approved backflow prevention assembly, backflow device, or an approved air gap to prevent backflow and shall meet all current cross-connection code requirements. Annual backflow prevention test certification results shall be maintained on-file and provided upon request to Department representatives.

D. Booster Heater Requirements

A booster heater shall be provided when a high-temperature warewashing machine is installed to pre-heat the water. A 140°F minimum incoming fresh hot water supply is required for high-temp dishwashing machines.

Based upon the primary incoming hot water supply of 140ºF, a booster heater is required to raise or "boost" the incoming hot water supply (gph demand) up 40ºF to attain the required 180ºF at the manifold for the final sanitizing rinse cycle.

Booster heaters for warewashing machines that use hot water for sanitizing are designed to raise the temperature of hot water to a level that ensures sanitization. If the volume of water reaching the

booster heater is not sufficient or hot enough, the required temperature for sanitization cannot be reached. Unless utensils are clean to sight and touch, they cannot be effectively sanitized.

A temperature gauge is required on the water supply line just before the booster heater. A pressure regulator is needed on the final rinse line. The flow pressure needs to be 15 to 25 psi (pounds per square inch).

Booster heaters shall be properly sized to meet the demand of the final sanitizing rinse cycle of the warewashing machine. A hot water supply line directly from a dedicated primary water heater shall be provided or a booster heater shall be provided within 5-feet of the warewashing machine to avoid heat loss in the supply lines. If the booster heater is installed more than 5-feet from the warewashing machine, the final rinse supply line from the booster heater to the warewashing machine shall be either re-circulated or equipped with approved self-regulating heat tape. A booster heater installed below a drain board shall be installed at least 6-inches above the floor and away from walls in a manner that will allow accessibility for adequate cleaning and servicing. A thermostatic mixing valve shall be installed to temper hot water if supplied to other appliances or fixtures.

E. Understanding Recovery Rate and First-Hour-Rating of Water Heaters

Recovery Rate - Defined as the capacity of a storage water heater (in gallons) to produce hot water in one hour or the amount of hot water the water heater is capable of providing in a given period of time. The recovery rate is not be confused with the first-hour rating, which includes the recovery rate plus 70% of the storage tank capacity. The recovery rate or amount of hot water a unit will provide is determined by several factors; wattage of heating elements or Btu, rise in temperature, and the amount of time to calculate the recovery rate.

Example: A 60-gallon gas-fired commercial water heater (50,000 Btu), with an incoming water temperature of 60ºF, and the thermostat set point is 120ºF (temperature rise of 60ºF), results in a recovery rate of 77gph. *(See Appendix 1).*

F. 70% Rule – First Hour Rating

A typical water heater will deliver 70% of its tank capacity at the thermostat set point minus 20ºF. The amount of water in the tank is multiplied by 70% because as the hot water is being used, new cold water is enters the water heater, mixing with and diluting the heated water in the tank. When a hot water faucet is turned on, cold water enters the inlet side of the water heater and is delivered to the bottom of the tank. The incoming cold water pressure pushes the hot water out of the tank. After sufficient cold water has entered the tank and mixed with the hot water, this will cause the water to turn cold. Simply, once a tank has used 70% of available hot water, the water in the tank will quickly become cold. The thermostat senses the cold water introduced into the tank and begins the heating process again. As the hot water is being used, the thermostat on the water heater will demand heat and the unit will start to recover. The water heater will heat water, even while hot water is being utilized. The recovery rate capacity of a water heater is factored in with the 70% rule to determine the first hour delivery rating.

First Hour Rating - The performance capability of a fully heated conventional storage water heater to provide hot water during the first hour peak demand in a facility is indicated by its "first hour rating" or first hour output. It is based on how many gallons of hot water can be delivered during the first hour of operation and determined by storage tank capacity and recovery rate.

Determining First Hour Rating -The first hour rating of a water heater is the calculated amount to describe the performance capacity of a water heater within the first hour of use when recovered to the water heater's thermostat set-point.

1. Begin with a fully heated tank of water.
2. An approximate first hour rating can be determined with the formula:

(Tank Capacity) x .70 (70%Rule) + (Recovery Rate) = First Hour Rating

3. Example: 60-gallon gas-fired commercial water heater (50,000 Btu), with an incoming water temperature of 60ºF, and the thermostat set point is 120ºF (temperature rise of 60ºF), the recovery rate is 77gph. 60 (gallons) x .70 + 77gph = 119gph first hour rating

IV. Conventional Storage Tank Water Heaters - Sizing Requirements

When determining hot water sizing requirements in permitted establishments, a conventional storage water heater shall have a recovery rate that is equal to or greater than 100% of the calculated hourly hot water demand, in gallons per hour (gph). These are minimum hot water sizing requirements, and it may be necessary to adjust the water heater size to a larger water heater based on the type of facility in order to provide a sufficient supply of hot water.

First, establish the peak demand for hot water in the establishment, measured in gallons per hour (gph). Then evaluate the storage tank water heaters on the same gph basis to determine how many gallons of storage are required to meet the peak demand.

Water heater storage capacity shall be sized as follows:

1. Water heater sizes are determined based on the number of faucets, fixtures, sinks, sizes of sinks, and the type of facility.
2. A 100% equal or greater hot water recovery rate is required for the water heater. It is determined by the computed hourly hot water demand in gph, and by the manufacturer's listed recovery rates in conjunction with a 60ºF water temperature rise.
3. Refer to the manufacturer's specification sheets ("cut sheets") for the particular makes and models of equipment when determining sizing capacity, or refer to Table-1 when estimating gph for appliances or fixtures.
4. When determining water heater calculations, if the result is a mixed number, round up to the nearest whole number digit. Only the final result of an actual calculation shall be rounded.
5. Unless otherwise specified, all calculated results shall be rounded to the nearest significant whole number digit and compliance with the specific water heater calculation shall be enforced.
6. Larger water heaters, additional water heaters, or a boiler may be necessary in ensure an adequate supply of hot water in a permitted establishment.
7. Combining water heater sizes to meet minimum water storage capacity requirements may be acceptable with prior approval.
8. It is not common for all fixtures in an establishment to be utilized simultaneously; therefore, a 75% allowance of the calculated hourly hot water demand may be granted if deemed appropriate (based upon fixture demand), and approved by the Department. Determined per facility and only on a case-by-case basis after a comprehensive review of measured and observed criteria.
9. The minimum storage capacity for establishments that handle and sell only pre-packaged retail food items (retail or wholesale) shall be 30-gallons.
10. The minimum storage capacity for an open food/beverage related establishment shall be 50-gallons.
11. The minimum storage capacity for an open food/beverage related establishment with an installed mechanical warewasher or washing machine shall be 75-gallons.
12. All other permitted establishments shall provide a minimum 30-gallon water heater.

❖ Table 1 – Hourly Hot Water Supply Requirements

The following table of common plumbing equipment types – appliance or fixture (based upon average equipment sizes) may be used approximate hot water supply requirements in gallons per hour (gph).

High GPH - To be used when multi-use eating utensils are utilized or in shared facilities.
Example - A full-service restaurant.

Low GPH - To be used in carry-out operations where single service eating utensils are utilized. Example – A quick-service restaurant or a retail grocery limited to only pre-packed items.

EQUIPMENT TYPE	**GALLONS PER HOUR (GPH)**	
	High	**Low**
Hand Sink	5	5
1-Compartment Food Preparation/ Rinse Sink	15	15
2-Compartment Food Preparation /Rinse Sink	30	30
3-Compartment Food Preparation Sink	45	45
Pre-Rinse Hose Sprayer	45	45
3-Compartment Warewash Sink	60	45
Service Sink (i.e. mop sink)	15	5
Separate Water Supply Line at Service Sink (Tempered or Hot Water)	15	5
Automatic Warewashing Machine (Door-Type Single Rack)	65	40
Chemical Sanitizing Glass Washer (Under counter Door-Type Single Rack)	40	20
1-Compartment Dump Sink	5	5
1-Compartment Blender Station Bar Sink	5	5
Bar 3-Compartment Sink	20	20
Bar 4-Compartment Sink	25	25
Hot Water Filling Faucet	15	15
Bain Marie	10	10
Coffee Urn	5	5
Kettle Stand	5	5
Clothes Washer: Domestic Unit[1]	50	25
Stackable Washing Machine Unit [2]	32	15
Large Commercial Clothes Washer	*	*
Hose Reel at Warewash Machine	45	45
Hose bib with Tempered/ Hot Water	50	50
Showerhead[3]	60	20
Garbage Can Washer[4]	50	50
Beer Keg Washer	*	*
Pressure Washer /Power Washer	*	*
Other Equipment Types	*	*

**Equipment specifications "cut sheets" are required.*

[1]*Clothes Washer (Domestic)* -The average use, in gph, is based upon 2 cycles per hour using standard 3.4 to 3.7 cubic ft. top or front loader washing machines.

High ……. 50-gallons
Low……... 25-gallons

[2]*Stackable Clothes Washing Machine* – The average use, in gph, is based upon 2 cycles per hour using a standard 1.5 cubic ft. stackable washing machine.

High……. 32-gallons
Low……. .15-gallons

[3] *Showerhead* - Federal regulations mandate that new low-flow showerheads have flow rates equal to or less than 2.5 gpm, which was mandated by the Energy Policy Act of 1992. The comfortable range for water from a shower head is around 102°F to 106°F. Although actual consumption varies with water pressure at the showerhead inlet and the exact flow rate may vary, a five minute shower using a low-flow showerhead could use 7-8 gpm. Older high-flow showerheads typically have a flow rate over 4 gpm. A five minute shower with an older unrestricted showerhead could use over 20-gallons. The United States Department of

Energy estimates that a typical low-flow showerhead consumes 7-gallons per use. (7-gallons per use x 3 shower uses per hour = 21 gallons per hour.) For low-flow showerheads or low-use applications, factor 21 gph, per showerhead. For older high-flow or high-use applications, factor 20-gallons per shower head x 3 shower uses per hour = 60 gallons per hour. Note: Bathtub demand shall be 20 gph.

[4]*Garbage Can Washer* - The water supply to garbage can washers shall be connected through an air gap by means of proper backflow protection. Garbage can washers shall not discharge through a plumbing trap serving any other device or fixture. The receptor receiving the waste water from garbage can washing shall be provided with a basket, strainer or similar device to catch large solid waste particles, thereby preventing their discharge into the building drainage system. The discharge from a garbage can washer shall be directed to a grease interceptor regulated by the local municipality or jurisdiction.

In the absence of specific hot water usage figures for equipment, the following may be used to provide an approximation for calculating sizes for hourly hot water demand:

Small Sinks…… 5-gallons per compartment
Other Fixtures……...Refer to manufacturer's specifications "cut sheets" for the equipment.

Sink Capacity Calculation - Square or rectangular NSF commercial approved sinks that have the same width at the top and bottom, and have straight sides with rounded corners. To calculate the capacity in cubic inches of sink volume of a square or rectangular sink, measure the inside length, width, and depth. Multiply the three measurements together to get the number of cubic inches that the sink will hold. Divide this number by 231 to determine the number of gallons the sink will hold, and multiply by .75 to account for sinks typically being filled three-quarters full (not to be confused with 75% allowance – see following section).

The gallon capacity size of a sink can be calculated using the following mathematical formula:

Gallon Capacity = (L x W x D) / 231x.75

1. Find the cubic inches of sink volume: L x W x D = Cubic Inches
   Example: 24" x 24"x 12" = 6,912 cubic inches

2. Find sink capacity in gallons: Cubic Inches/ 231 = gallons in sink
   Example: 6,912 cubic inches/ 231 = 29.9 gallons in sink

3. Multiple times number of compartments = Total gallon capacity in gph.
   Example: 29.9 gallons per sink x 3 compartments = 89.7 gallons or 90 gph for a 3-comp.

4. Multiply times .75 to account for sink being filled only three-quarters full.
   Example: 90 gallons x .75 = 67.5 or 68 gph for a 3-comp.

75% Allowance for the Calculated Hourly Hot Water Demand

It is not common for all fixtures in an establishment to be utilized simultaneously; therefore assuming that not all fixtures will be used at the same time, a 75% allowance of the calculated hourly hot water demand may be granted if deemed appropriate (based upon fixture demand), and approved by the Department only when sizing the hot water storage capacity for conventional tank water heaters.

Example – A calculation determines that a 105 gph (high) water heater is needed and a 75% gph calculation allowance is granted, factoring a 60°F water temperature rise:

105 gph x .75% allowance = 78.75 gph. A minimum 75-gallon tank water heater is required.

** 75% allowance is not to be confused with the 70% rule. See section III, F: 70% Rule – First Hour Rating regarding hot water recovery rates.*

❖ Table 2 - Sample "Low" & "High" GPH Allowance Calculations

The following sample calculations are provided to explain how to calculate the total hourly hot water demand in the absence of specific hot water usage figures for equipment, factoring a 60°F water temperature rise.

1. A food establishment that utilizes only single service eating and drinking utensils:
   Assume a "Low" gph calculation:

1	3-Compartment Sink	45 GPH
3	Hand sinks (kitchen & restroom)	15 GPH (5 GPH each)
1	Service Sink	5 GPH
1	1-Compartment Food Preparation/ Rinse Sink	15 GPH
		70 GPH total hourly hot water demand

   70 GPH x 75% allowance for low usage establishment = 52.5 or 53 GPH
   For the food establishment in this example, a water heater will be required which will recover 53 gallons per hour and have a minimum 50-gallon hot water storage capacity.

2. A food establishment that utilizes multiservice eating and drinking utensils:
   Assume a "High" gph calculation:

1	3-Compartment Sink	60 GPH
3	Hand sinks (kitchen & restroom)	15 GPH (5 GPH each)
1	Service Sink	15 GPH
1	1-Compartment Food Preparation/ Rinse Sink	15 GPH
		105 GPH total hourly hot water demand

   105 GPH x 75% allowance for low usage establishment = 78.75 or 79 GPH
   For the food establishment in this example, a water heater would be required that will recover 79 gallons per hour and have a minimum 50-gallon hot water storage capacity, provided a mechanical warewasher machine is not installed. However, in this scenario a 75-gallon storage capacity water heater is highly recommended.

3. Food establishment that utilizes multiservice eating and drinking utensils and utilizes an automatic warewashing machine:

   Assume "High" gph calculation:

1	3-Compartment Sink	60 GPH
4	Hand sinks (Kitchen & Restrooms)	20 GPH (5 GPH each)
1	Service Sink	15 GPH
1	1-Compartment Food Preparation/ Rinse Sink	15 GPH
1	Automatic Warewashing Machine	65 GPH
		175 GPH total hourly hot water demand

   175 GPH x 75% allowance for low usage establishment = 131.25 or 131 GPH
   For the food establishment in this example, a water heater will be required which will recover 131 gallons per hour and have at a minimum a 75-gallon hot water storage capacity. However, in this scenario a 100-gallon storage capacity water heater is highly recommended.

V. Tankless Water Heaters - Sizing Requirements

When determining hot water sizing requirements in permitted establishments, a tankless water heater shall be sized properly, in gallons per minute (gpm), of hot water that it generates on demand and is capable of supplying continuous hot water without the use of a storage tank.

An establishment's total gpm anticipated fixture/faucet demand shall be calculated in order to determine the overall gpm factoring a 60ºF temperature rise necessary to meet the overall hot water requirements of the establishment.

An advantage of a tankless water heater or instantaneous water heater is its ability to provide a continuous supply of water upon demand, because there is no wait for a storage tank to fill up with sufficient hot water. Tankless water heaters are energy efficient because they are off when not in use, and they modulate their firing rate based upon demand. However, since cold water passes through a heat exchanger, the cold water must flow through the unit slowly to assure adequate heat transfer. Therefore, the rate at which hot water upon demand is provided can be significantly less than that provided by a storage water heater.

While tankless water heaters do not run out of hot water, if not sized properly, the flow rate of hot water can be adversely impacted. The temperature at a hot water fixture may remain the same, but the flow could slow to a trickle. The flow rate is essential, since tankless water heaters will generate a temperature rise based on the flow rate demanded. Typical tankless water heaters are capable of providing hot water at a rate of 3 to 6 gallons per minute at a 60ºF water temperature rise. Gas-fired tankless water heaters usually produce significantly higher flow rates than electric tankless water heaters.

Smaller tankless water heaters may not be capable of supplying hot water for simultaneous demand from multiple fixtures in establishments. For example, using sinks and running an automatic warewashing machine may exceed the hot water supply capability of a tankless water heater. To overcome this problem, provide multiple tankless water heaters connected in parallel to meet the simultaneous demands of hot water. Also, a separate tankless water heater can be installed to provide hot water exclusively to an automatic warewashing machine or to other fixtures that consume a lot of hot water in the establishment.

Small under sink or under counter instantaneous "insta-hot" type tankless water heaters are designed primarily for limited use to meet the total hot water demand of the fixture service and are limited to approved single point-of-use applications due to their design limitations, such as hand wash sinks, hot water beverage fill stations, etc. These small "insta-hot" water heaters also lack hot water storage and have restricted flow rates; consequently, few are capable of supplying an adequate flow rate of water to multiple fixtures are not allowed to be installed for use at appliances or fixtures requiring a high hot water supply demand/flow volume rate, such as a service sink.

When hot water is required at the same time at multiple locations in a permitted establishment the flow of hot water to each fixture may be severely restricted. Because of this restricted flow rate and output from tankless water heaters, more than one tankless water heater may be required, based upon the number of sinks, appliances, fixtures and equipment present in the establishment.

Therefore, due to the inherent design limitations of tankless water heaters, the units are restricted, require thorough review, and are approved only on a case-by-case basis. All tankless water heaters require final on-site approval by the Department, including tankless water heater systems designed with hot water storage tanks. Descaling shall properly be done as necessary and according to manufacturer's recommendations.

The venting of gas-fired tankless water heaters is very important. Existing gas lines may not be adequate to supply enough gas for the unit to function properly at peak demand. Do not assume that if an existing gas line is the same size to the tankless water heater that the gas supply pipe is large enough.

It is recommended that the installation of tankless water heaters be performed by a licensed and insured contractor, and the final installation be approved by the local building department.

A tankless water heater shall be sized as follows:

1. Tankless water heaters shall be sized to provide adequate hot water of at least 120ºF.
2. Factor a 60ºF water temperature rise.
3. Hot water flow rate is calculated in gallons per minute (gpm) and not in gallons per hour (gph).
4. The calculated flow rate per minute shall be 2 gpm to each individual sink, faucet, service sink, appliance, fixture, or shower head that utilizes hot water or tempered water.
   Example: Dual faucets on a 3-comp. sink - (2) faucets x 2 gpm = 4 gpm
5. Hand sink faucets shall be calculated at 0.5 (½) gpm.
6. Note: All flow volumes are estimates and demands may vary above 2 gpm for various appliances or fixtures. Average gpm figures are based upon typical gpm requirements and plumbing standards.
7. Small point-of-use instantaneous "insta-hot" water heaters are approved only for hand sink use. Warewash sinks, food prep sinks, service sinks, appliances and other fixtures require a hot water supply from a larger approved water heater source.
8. Metered faucets used at restroom hand sinks may not allow sufficient hot water to flow to the fixtures, and their installation may be restricted. Metered faucets are not recommended to be utilized in conjunction with tankless water heaters due inadequate hot water flow to the faucets.
9. Automatic warewashing machines appliances and other fixtures that utilize large quantities of hot water may be required to provide a dedicated tankless water heater in order to supply hot water exclusively to the automatic warewashing machine.
10. Manufacturer specification sheets "cut sheets" shall be provided for review of the tankless water heater. Additional cut sheets shall be submitted for other equipment and appliances as requested.
11. When determining final water heater calculations, if the result for the number of tankless units required is a mixed number, the number is rounded up to the next whole number digit in order to obtain the minimum number of tankless units required. Only the final result of an actual calculation for number of tankless units required shall be rounded up.
12. Unless otherwise specified, calculated results shall be enforced and in compliance with the rounded water heater calculation.
13. If determined acceptable, Department staff may allow for the rounding of (+/-) 2 gpm to the nearest whole digit number of tankless units required in order to achieve adequate minimum water heater sizing. Determined per facility on a case-by-case basis after a comprehensive review of measured and observed criteria.

❖ **Table 3 - Tankless Water Heater Sample Calculation**

1	3-Compartment Sink – (1) faucet	2 GPM
4	Hand sinks (kitchen & restroom) (1/2 gpm each)	2 GPM
1	Service Sink	2 GPM
1	1-Compartment Food Preparation/ Rinse Sink	2 GPM
		8 GPM total hourly hot water demand*
		**Factor 60ºF water temperature rise.*

In the example given above, one or more tankless water heaters are required in order to provide a 60ºF temperature rise at 8 gpm for a desired hot water output of 120ºF.

VI. Automatic Mechanical Warewashing Equipment Specifications

A. Temperature Measuring, Data Plate Operating Specifications

Water temperature measuring devices on warewashing machines shall have a numerical scale, printed record, or digital readout in increments no greater than 1ºC or 2ºF in the intended range of use.

A warewashing machine shall be equipped with a temperature measuring device that indicates the temperature of the water in each wash and rinse tank; and as the water enters the hot water sanitizing final rinse manifold, or in the chemical sanitizing solution tank.

A warewashing machine shall be provided with an easily accessible and readable data plate affixed to the machine by the manufacturer that indicates the machine's design and operation specifications including; temperatures required for washing, rinsing, and sanitizing; pressure required for the fresh water sanitizing rinse unless the machine is designed to use only a pumped sanitizing rinse; and conveyor speed for conveyor machines, or cycle time for stationary rack machines.

B. Flow Pressure, Flow Pressure Gauges/Devices

If the flow pressure of the final sanitizing rinse is less than that required in low-temperature warewashing machine, dispersion of the sanitizing solution may be inadequate to reach all surfaces of equipment or utensils. Flow pressure is a very important factor affecting the efficacy of sanitization in warewashing machines that use fresh hot water as a final sanitizing rinse in high-temperature warewashing machines. A pressure below the design pressure results in inadequate spray patterns and incomplete coverage of the utensil surfaces to be sanitized. Excessive flow pressure will tend to atomize the water droplets needed to convey heat into a vapor mist that cools before reaching the surfaces to be sanitized.

Warewashing machines that provide a fresh hot water sanitizing rinse shall be equipped with a pressure gauge or similar device such as a transducer that measures and displays the water pressure in the supply line immediately before entering the warewashing machine; and if the flow pressure measuring device is upstream of the fresh hot water sanitizing rinse control valve, the device shall be mounted in a one-fourth inch (¼) iron pipe size (IPS) valve. This does not apply to warewashing machine that uses only a pumped or re-circulating sanitizing rinse, since adequate pressure is provided by a pump that is not dependent upon line-pressure. "Fill and Dump" type warewashing machines do not require a pressure-reducing valve or pressure gauge, as the final rinse is supplied by the machine's pump.

If a manufacturer's data plate indicates a flow pressure, the warewashing machine shall be provided with a pressure gauge or similar device including, but not limited to a transducer that measures and displays the water pressure in increments not greater than 1 psi. If the data plate does not state a flow pressure, the warewashing machine is not required to be equipped with a pressure gauge valve.

It is important that an establishment monitor and a Department inspector verify water temperatures, as well as the final sanitization rinse pressure in warewashing machines. ANSI/NSFI (National Sanitation Foundation International) Standard #3 specifies that an accurate pressure gauge or similar device be provided on warewashing machines.

NSFI states the final rinse optimum pressure is 20-psi. The acceptable flow pressure of the fresh hot water sanitizing rinse pressure in a warewashing machine shall not be less than 15-psi nor more than 25-psi as measured with a pressure gauge with an accuracy of ±2 psi in the operational range (15-25 psi), as measured in the water line immediately downstream from the fresh hot water sanitizing rinse control valve.

The flow pressure of the fresh hot water sanitizing rinse in a warewashing machine, as measured in the water line immediately downstream or upstream from the fresh hot water sanitizing rinse control value, shall be within the range specified on the machine manufacturer's data plate and may not in

any case be less than 35 kilopascals (5 pounds per square inch) or more than 200 kilopascals (30 pounds per square inch).

C. Low-Temperature Warewashing Machines

The temperature of the wash solution in a mechanical spray-type warewashing machine that uses a chemical (i.e. chlorine) to sanitize may not be less than 120ºF. In all food service establishments in which a warewashing machine uses a chemical for sanitization, an approved device that indicates audibly or visually when the sanitizer level is low must be installed.

D. High-Temperature Warewashing Machines

The temperature of hot water delivered from a high-temperature warewashing machine sanitizing rinse manifold must be maintained according to the equipment manufacturer's specifications and temperature limits specified in code to ensure surfaces of multiuse utensils such as kitchenware and tableware accumulate enough heat to destroy pathogens that may remain on such surfaces after cleaning.

In all automatic warewashing machines that use hot water to sanitize, the wash solution temperature may not be less than 150°F. The hot water wash solution temperature must be 150°F to 165°F for effective washing.

For purposes of sizing the hot water generating capability, when a hot water sanitizing warewashing machine is used, a booster heater must be provided that will raise the incoming hot water supply temperature requirement of 140ºF up to at least 180°F for the final sanitizing rinse cycle in a high-temperature automatic warewashing machine. Please refer to the booster heater requirements in this guideline.

The final fresh hot water rinse temperature at the manifold for a stationary rack mechanical warewashing machine shall be at least 165°F; for all other machines it shall 180°F in high-temperature automatic warewashing machine. These lower temperatures limits are based on the sanitizing rinse contact time required to achieve a 160°F utensil/plate surface temperature.

The final rinse cycle shall achieve a small-ware surface temperature of at least 160°F at the plate as measured by an irreversible registering temperature measuring indicator/device to affect sanitization. This surface temperature shall be measured using an approved accurate irreversible registering temperature indicator, holding thermometer, or other approved methods. The hot water rinse temperature must be 165°F to 180°F at the manifold in order to achieve proper sanitizing at the utensil/plate.

In mechanical warewashing equipment utilizing hot water for sanitizing, the temperature of the fresh hot water sanitizing rinse as it enters the manifold may not be more than 194°F, as the water becomes volatile and begins to vaporize reducing its ability to convey sufficient heat to utensil/plate surfaces. This specified maximum temperature does not apply to the high pressure and temperature systems with wand-type, hand-held, spraying devices used for the in-place cleaning and sanitizing of equipment such as meat saws.

VII. Water Heater Buying/Replacement Recommendations

Is it time to consider the installation of a new conventional storage water heater in a permitted establishment?

1. Does your facility now require additional hot water due to increase use or demand from additional appliances or fixtures utilizing hot water?
2. Is your current water heater old, leaking, corroded, in poor repair, or not functioning properly?

3. Consider the age and repair costs. Can it be repaired? Has the warranty expired?
4. Are the facility's energy bills increasing?

Energy source – Selecting an electric or gas water heater
Conventional storage electric and gas water heaters are very similar; however there are principle differences between the two. Electric water heaters use two heating elements to heat water. Gas water heaters utilize a gas burner located at the bottom. Gas water heaters typically use less energy and are less expensive to operate than models of a similar size. It is recommended that gas-fired water heaters be installed when possible.

Selecting an appropriate water heater -

1. Choose the appropriate storage tank gallon capacity by considering the energy source, energy efficiency, capacity to handle peak demand, recovery rate, and first hour rating output.
2. Consider the unit and location dimensions - Will the new water heater fit in the current space? Factor into consideration proper dimensions if upgrading to a larger sized unit.
3. Consider self-cleaning models that are equipped to prevent/reduce lime and sediment buildup.
4. Length of the unit's limited warranty. It is advisable to purchase the longest warranty possible. Longer warranties are good indication of better quality and tend to have larger heating elements, thicker insulation, and thicker or longer corrosion fighting metal anodes.
5. All applicable local codes and permits shall be met prior to installation.
6. Professional installation is strongly recommended and may be required by the local municipality.
7. Selecting the appropriate water heater may end up saving the facility money in the long term.
8. It is recommended to have the water heater serviced annually by a qualified technician.

Selecting a type of water heater -
The size of your establishment, the number of appliances, fixtures, peak demand, the utility service provided in your area and the space available for your water heater all factor into determining how to choose the best water heater for your permitted facility. It's important to keep the following things in mind:

1. Storage tank water heaters – the most common type used and the best water heaters to buy. These water heater units are designated by the amount of water they hold in gallons, recovery rate, have an insulated tank where water is heated and stored until it's needed. The units are available in electric, liquid propane (LP) and natural gas models. Natural gas and LP water heaters typically utilize less energy and are less expensive to operate than electric models of the same capacity. Verify the dimensions of the space where your water heater is installed. If your hot water usage increases, you will need to upgrade to a larger tank size, it may be necessary to run plumbing to a different area so the new, larger water heater unit will fit. One alternative to running new plumbing is to purchase a lowboy model water heater. These units are shorter and bigger around the circumference than typical water heaters, allowing them to hold the same amount of water as their larger counterparts, but still may be installed in areas with limited headroom space.
2. Point-of-use water heaters – are typically smaller storage tank water heaters that are great choices for providing hot water in remote or secondary locations. These water heaters typically range in size from 2.5 to 30-gallons.
3. Hot water dispensers/meters – small point-of-use water heaters that can provide 190°F hot water instantly for food and beverage production convenience. These units are installed for making soups, hot cocoa, tea, sauces, oatmeal, instant potatoes, other instant foods, dough, etc. can provide hot
4. Tankless water heaters – are water heaters that do not store hot water; rather, they heat water as it passes through a series of coils inside the unit. These on-demand, instantaneous water

heaters generate hot water on demand and can deliver a continuous supply of hot water without the use of a storage tank. Tankless water heaters are typically more energy-efficient than a traditional storage tank water heater, since the unit only heats the water when it is used.

VIII. Legionnaire's Disease and Health Related Concerns

The following information is intended to provide helpful information regarding the potential dangers of stored water temperatures that have been directly associated with the growth of harmful bacteria, as well as understanding potential water heater scald hazards.

Legionella

A risk associated with water heater systems is exposure to *Legionella* pneumophilia bacteria. Legionnaire's Disease is caused by a type of bacteria called *Legionella* and has been associated with water heater systems in a number of outbreaks since it was first identified in 1976. Legionnaire's disease is an infection of the lungs and is a form of pneumonia. A person may acquire the disease by inhaling water mist contaminated with the bacteria. Aerosolized water droplets containing the bacteria may be transmitted through a variety of sources and make their way into the lungs. Under low levels of contamination, the risk of obtaining the disease from contaminated water is very slight. The risk arises when high concentrations of the bacteria are present in water systems.

The *Legionella* bacteria are present at low levels in water environments such as lakes, rivers, streams, and ponds. The bacteria are commonly found in potable water supplies and grow well in warm water nutrient rich hot water systems, faucets, plumbing fixtures, plumbing systems, hot tubs, decorative fountains, cooling towers, evaporative condensers, evaporative coolers "swamp coolers", humidifiers, misters, emergency showers and eyewash stations, shower equipment, other similar warm water environments. The bacteria may even be transmitted to humans by choking or aspirating while drinking water containing the bacteria.

Warm, stagnant water temperatures between 68°F to 122°F provide the idea conditions for *Legionella* to multiply. Temperatures between 90°F to 105°F are ideal for growth. Scale, rust (iron), biofilm, and the presence of other microorganisms can promote the growth of *Legionella.*

Large water heater systems frequently contain tepid zones, scale and sediment accumulations, "dead leg" sections of plumbing, non-recirculation plumbing lines, and temperatures maintained below 140°F. These conditions promote the environment required for the growth of *Legionella* and other microorganisms.

Properly maintaining a hot water system will prevent conditions that promote the growth of microorganisms by frequenting flushing lines, disinfecting the system using an approved treatment method, periodically draining hot water tanks to remove scale and sediment, providing recirculating plumbing lines will prevent stagnation. Providing proper backflow preventers and testing them to prevent cross-connections of potable water will reduce the growth of *Legionella* bacteria.

Maintaining water heater systems at 140°F or higher and providing water to faucets at a minimum of 122°F will reduce the growth and likelihood of *Legionella* and other microorganisms in the water.

The use of domestic type electric type water heater systems are more prone to be contaminated by *Legionella.* Due to design variables of the units and lower temperature settings, a higher percentage of electric water heaters may be contaminated in the bottom of a tank, and is a significant factor leading to contamination in hot water. The risk of contamination is much lower for fossil fuel (e.g. natural gas, propane) water heaters and it is drastically reduced when these types of water heaters are set at 140°F. It is recommended that electric water heaters be set at 140°F or fossil fuel water heater systems be utilized in permitted establishments.

The Department recommends hot water systems be designed to recirculate water. Eliminate or minimize "dead legs" in plumbing lines when possible to reduce stagnation. Provide heat tracing if necessary to maintain 122°F in plumbing lines. The installation of point-of-use water heaters will assist in reducing stagnation of water in infrequently used plumbing lines.

Scald Hazards

Temperatures at a plumbing point-of-use over 120°F are considered a safety hazard. There is a misconception that relying only on the water heater system's thermostat setting will provide a constant and safe water temperature. Improperly designed hot water systems may lead to scalding. To prevent the potential serious risk of being scalded by hot water, provide appropriate scald prevention devices (e.g. temperature actuated mixing valves, automatic compensating mixing valve, temperature liming device) to lower the risk of scalding at points of hot water delivery.

The use of specific tempering valves allows an establishment to maintain hot water at 140°F or higher, reducing *Legionella* inside hot water tanks and systems by mixing cold water with hot water to provide an appropriate and/or safe water temperature at a plumbing point-of-use, including tepid water compliant emergency eyewash and shower equipment stations.

Informational Links

For additional information concerning Legionnaire's Disease and hot water systems please refer to The United States Occupational Safety & Health Administration (OSHA).
https://www.osha.gov/dts/osta/otm/legionnaires/hotwater.html

For additional information to understanding potential water heater scald hazards please refer to the American Society of Sanitary Engineers (ASSE).
http://www.asse-plumbing.org/WaterHeaterScaldHazards.pdf

Appendix I - Btu and kW

One way to estimate the projected hot water demand in gph for the final rinse of mechanical warewashing machines, pot and pan washers and silverware washers, is to refer to the manufacturer's specification sheet "cut sheet" for the particular make and model of the machine.

In order to determine the required capacity and recuperative rate of the hot water generating equipment it will be necessary to calculate both the demand in gph and temperature rise required (assume an incoming water temperature of 60°F to the food establishment unless specific temperature data are available) for each piece of equipment.
These figures can then be converted to Btu (for gas-fired heaters) or kW (for electrical heaters). The required Btu or kW capacity of the heater will then be determined by adding up the individual Btu or kW requirements for each piece of equipment. 1,000 Btu input will heat 0.84 gallons of water at a 100°F rise in temperature. 1,000 Watts (1kW) will heat 4.1 gallons of water at a 100°F rise in temperature.

Thermally efficient gas-fired water heaters as rated by the EPA Energy Guide® which measures the energy factor - the overall annual operating efficiency of the water heater, taking into consideration loss of energy due to combustion, radiation, convection, and the conduction of heat from the unit listed by a nationally recognized testing laboratory. For the purpose of the guideline the thermal operating efficiency will be assumed to be .70%, unless otherwise listed by NSF International or other nationally recognized testing laboratories.

To convert to Btu or kW, use the following formulas: (1-gallon of water = 8.33lbs)

For gas-fired heaters (in Btu):

$$\text{Required Btu} = \frac{\text{Gallons per hour of water x Temp. rise x 8.33}}{\text{.70 (operating efficiency)}}$$

For electrical heaters (in kW):

$$\text{Required kW} = \frac{\text{Gallons per hour of water x Temp. rise x 8.33}}{\text{3412 (Btu's per kW)}}$$

The following example will illustrate use of the above method of approximating the size of the hot water heater needed for specified equipment:

Equipment	GPH Demand from Chart	Temperature Required	Temp. Rise
3-Comp Sink	60	140°F	80°F

$$\frac{\text{60 (GPH) x 80 degree temp. rise x 8.33}}{\text{.70 (operating efficiency)}} = \text{57,120 Btu}$$

OR

$$\frac{\text{60 (GPH) x 80 degree temp. rise x 8.33}}{\text{3,412 (Btu per kW)}} = \text{11.72 kW}$$

Assumes an incoming water temperature of 60°F into the establishment.

Equipment	GPH Demand from Chart	Temperature Required	Temp. Rise
Handsink	5	110°F	50°F

$$\frac{\text{5 (GPH) x 50 degree temp. rise x 8.33}}{\text{.70 (operating efficiency)}} = \text{2,975 Btu}$$

OR

$$\frac{\text{5 (GPH) x 50 degree temp. rise x 8.33}}{\text{.98 x 3,412 (Btu per kW)}} = 0.6228 \text{ kW}$$

Assumes an incoming water temperature of 60°F into the establishment.

Equipment	GPH Demand from Chart	Temperature Required	Temp. Rise
Warewashing Machine	65	140°F	80°F

$$\frac{\text{65 (GPH) x 80 degree temp. rise x 8.33}}{\text{.70 (operating efficiency)}} = 61{,}880 \text{ Btu}$$

OR

$$\frac{\text{65 (GPH) x 80 degree temp. rise x 8.33}}{\text{3,412 (Btu per kW)}} = 12.70 \text{ kW}$$

Assumes an incoming water temperature of 60°F into the establishment and hot water heater delivery of 140°F hot water to the unit.

Equipment	GPH Demand from Chart	Temperature Required	Temp. Rise
Warewashing Machine With Booster Heater	65	180°F	80°F

$$\frac{\text{65 (GPH) x 80 degree temp. rise x 8.33}}{\text{.70}} = 61{,}880 \text{ Btu}$$

OR

$$\frac{\text{65 (GPH) x 80 degree temp. rise x 8.33}}{\text{3,412}} = 12.70 \text{ kW}$$

For mechanical warewashing machine, assume a hot water demand based on a primary rise in temperature to 140°F. A booster heater must then be provided to boost the required GPH demand an additional 40°F to attain the required 180°F final temperature, which = 30, 940 Btu or 6.35 kW.

For the above example, the total demand in Btu's or kW's for the primary water heater would be:

3-Compartment sink	= 57,120 Btu or 11.72 kW
1 Handsink	= 2,975 Btu or 0.61 kW
1 Warewashing Machine	= 61,880 Btu or 12.70 kW
TOTAL PRIMARY DEMAND	= 121,975 Btu or 25.03 kW

However, a booster heater for the warewashing machine must be provided and sized adequately to supply an additional 30,940 Btu or 6.35 kW for a total overall use of 92, 820 Btu or 19.05 kW.

Appendix II - Hot Water Calculation Worksheet for Conventional Storage Tank Water Heaters

Maricopa County Environmental Services
Plan Review and Construction Program
Hot Water Storage Tank Calculator (GPH)

Establishment Name:	
Address:	
Establishment Type:	
Permit Number:	
Date:	
Water Heater Model #:	

Sink Type	Quantity	High	Low	Total High	Total Low
Hand Sink		5	5	0	0
Prep Sink		15	15	0	0
3-Compartment Sink		60	45	0	0
Service Sink		15	5	0	0
Dishwasher (Avg)		65	40	0	0
Pre-Rinse Sprayer		45	45	0	0
Bar 3-Comp Sink		20	20	0	0
Bar 4-Comp Sink		25	25	0	0
Dump Sink		5	5	0	0
Can Wash		50	50	0	0
Coffee Urn		5	5	0	0
Blender/Dump Sink		5	5	0	0

Custom Sinks	Length	Width	Depth	Total High	Total Low
4-Compartment Sink				0.0	0.0
3-Compartment Sink				0.0	0.0
2-Compartment Sink				0.0	0.0
1-Compartment Sink				0.0	0.0

Specialized Equipment	Manufacturer Specifications - GPH	Total High	Total Low
Dishwasher 1		0.0	0.0
Dishwasher 2		0.0	0.0
Shower Head		0.0	0.0
Other		0.0	0.0
Other		0.0	0.0

Refer to dishwasher model cut sheets for GPH specs. Enter value under ***Manufacturer Specifications - GPH above*** *.*

GPH = Gallons Per Hour

Total GPH:	0	0

Reviewer Signature and Date:

Appendix III - Hot Water Calculation Worksheet for Tankless Water Heaters

Maricopa County Environmental Services
Plan Review and Construction Program
Tankless Water Heater Calculator (GPM)

Establishment Name:	
Address:	
Establishment Type:	
Permit Number:	
Date:	
Tankless Heater Model #:	

Sink and Faucet Type	Quantity	Gallons Per Minute	Total GPM
Hand Sink Faucet		0.5	0.0
Warewash Sink Faucet		2.0	0.0
Prep Sink Faucet		2.0	0.0
Service Sink Faucet		2.0	0.0
Can Wash Faucet		2.0	0.0

*Remember to calculate based on the number of **faucets**, not compartments.*

GPM = Gallons Per Minute

Other Equipment	Quantity	Gallons Per Minute	Total GPM
Pre-rinse Sprayer		2.0	0.0
Bar Dishwasher		0.0	0.0
Kitchen Dishwasher		0.0	0.0
Shower Head		0.0	0.0
Other Equipment		0.0	0.0
Other Equipment		0.0	0.0

*Refer to dishwasher and equipment model cut sheets for GPM specs. Enter value under **Gallons Per Minute** above.*

Total GPM Required:	0.0
GPM Provided By Model #:	0.0
Number of Tankless Units Required:	0.0
Number of Tankless Units Required, Rounded Up:	0

*Note: you must enter the **GPM Provided by Model** value.*

Reviewer Signature and Date:

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This guide is the cumulative result of efforts and recommendations of many contributing individuals, agencies, codes, and organizations with years of experience in assessing minimum requirements for the safe operation of permitted establishments within Maricopa County. Plan Review & Construction Program staff and management spent considerable time and effort in addressing concerns and developing recommendations that are included in this guide. Maricopa County Environmental Services acknowledges with gratitude the contributions of many public health representatives, agencies, regulators, companies, professional groups, industry representatives, and the FDA whose substantial knowledge contributed to this guideline.

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- United States Food and Drug Administration (FDA) Food Establishment Plan Review Guide 2000.
- FDA Food Establishment Plan Review Guide, Section III, Part 9, Hot Water Supply Requirements.
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- Centers for Disease Control & Prevention (CDC), *Legionella* in the Environment, Cause & Transmission, February 5, 2013.
- Southwest Gas Corporation, Food Demonstration Center, 1600 E. Northern Avenue Phoenix, Arizona 85020
- On-line open source industry educational and reference materials.
- United States Occupational Safety & Health Administration (OSHA), Legionnaires Disease
- American Society of Sanitary Engineers (ASSE) Water Heater Scald Hazards.pdf, March 2012

Suggestions

We welcome your feedback. The Plan Review & Construction Program is focused on continuous process improvement. Suggestions for changes will be taken into consideration and are welcomed from all users. Revisions to the guideline and related plan review guidance documents are made periodically as needed. Thank you taking the time to submit your ideas.

Please submit suggestions to: ESPlanReview@mail.maricopa.gov

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to ensure a safe and healthy environment

Environmental Services Department