SECTION K - HOT WATER SUPPLY REQUIREMENTS[1]

REFERENCES (DPH Chapter 511-6-1)

.06 Sanitary Facilities and Controls. Amended. (1) Water Supply. (g) Capacity 2
.06 Sanitary Facilities and Controls. Amended. (2) Plumbing System. (c) Hand Sink Installation.
.05 Equipment and Utensils. Amended. (2)Design and Construction (bb) Manual Warewashing Equipment, Heaters and Baskets. 1
.05 Equipment and Utensils. Amended. (6)Maintenance and Operation. (j) Mechanical Warewashing …1& 2
(k) Manual Warewashing Equipment, Hot Water Sanitization Temperatures.
.05 Equipment and Utensils. Amended. (6) Maintenance and Operation (l) Mechanical Warewashing … 1& 2
.05 Equipment and Utensils. Amended. (6) Maintenance and Operation (n) Manual & Mechanical Warewashing.

I. Background:

1. Purpose:

A. *A critical factor in preventing foodborne illnesses in a food service establishment* is the provision of a sufficient supply of hot water to meet the demand of the establishment (i.e., for the washing of hands, utensils, equipment, and the cleaning of the establishment itself). *The installation of a properly sized hot water generation system (i.e., water heater plus associated plumbing system) will ensure that a sufficient amount of hot water will be available at all times to meet this demand.*

B. *The purpose of these guidelines* is to provide a set of criteria that will assist architects, designers, contractors, the food service establishment permit applicant, and the permit holder in the proper sizing of water heating equipment *to reasonably meet the peak hot water demand of food service establishments in Georgia*. Likewise, these guidelines are to function as an aid to the Health Authority in its evaluation of water heating equipment and related systems, during the plan review process. Therefore, food service establishments with water heating equipment sized according to these criteria should be capable of reasonably complying with the requirements for providing a hot water supply to satisfy the continuous and peak hot water demands of the establishment.

C. When reviewing hot water generating equipment and related systems, *the key to remember* is that the reviewer is only trying to verify *whether or not the proposed equipment and system will reasonably be able to accommodate the requirement to provide an adequate hot water supply where it is needed within the establishment. This key is exactly what is specified within DPH Rule 511-6-1-.06 (1) (g) 2.*

[1] Reference Sources: Current Federal Food and Drug Administration (FDA)'s Plan Review for Food Establishments Course FDA #FD207; Guidelines For Sizing Water Heaters – September, 1995 - as published by the "California Conference of Directors of Environmental Health" and recommended within Section III, Part 9 of the "2000 FDA Food Establishment Plan Review Guide" as published by the Food and Drug Administration and Conference for Food Protection; Food Establishment Specification Form, Tri-County Health Department, Greenwood Village, CO 8011 as reference from within the current Food and Drug Administration (FDA)'s Plan Review Course #FD207; and DPH Chapter 511-6-1.

2. General Requirements:

A. *Water heating equipment manufacturer's specification sheets (i.e. cut sheets)* must be consulted during the evaluation of hot water supply equipment and associated systems. *See Illustration K-2 Manufacturer Specification Sheet for an example.*

B. *All water heating equipment, their installation, and all associated piping systems* must be in compliance with all applicable Federal, State, and local building and plumbing code requirements. Plans and specifications must list these applicable codes for reference by the Health Authority.

C. All hot water generating equipment must *conform to nationally recognized standards and be certified or classified by an American National Standards Institute (ANSI)-accredited certification program.*

D. *All newly constructed, change in ownership, or existing buildings being converted into a food service establishment* shall be provided with a hot water supply that is dedicated to the food service operation and sufficient to satisfy the continuous and peak hot water demands of the food service establishment. Hot water for hand washing shall be tempered water at a temperature of at least 100°F (38°C) and the temperature shall be regulated by means of a mixing valve or combination faucet. Hot water for mechanical warewashing must be boosted up to 150ºF(66ºC)to 165ºF (74°C) for washing and 165ºF(74°C) to 180ºF(82°C), not to exceed 194°F (90°C), for sanitizing or according to the manufacturer's data plate on the machine. The maximum sanitizing temperatures of 165°F (74°C) to 180°F (82°C), not to exceed 194°F (90°C) do not apply to high pressure and temperature systems with wand-type, hand-held, spraying devices used for in-place cleaning and sanitizing of equipment such as meat band-saws[2]. The temperature of the wash solution in spray-type warewashers that use chemicals to sanitize shall not be less than 120°F (49°C). The temperature of the wash solution in manual warewashing equipment shall be maintained at not less than 110°F (43°C) or the temperature specified on the cleaning agent manufacturer's label instructions. The water temperature for *manual hot water sanitization*[3] must be at least 171°F (77°C). *See Illustration K-3 for examples of equipment that provide or utilize hot water in their operation.*

E. *Specific data for determining water temperature coming into the establishment* can be received from the public water authority having jurisdiction where the establishment is located. The water temperature must reflect the coldest temperature of the year as it leaves the water authority's treatment plant to be distributed into its water system. However, if incoming water to the food service establishment is from a non-public well supply, the incoming water temperature must be based on ground water temperature during the coldest period of the year.

[2] & [3] See Illustration K-3 for example water heater for the sanitizing compartment of a warewashing sink and an example of food equipment that requires in-place cleaning methods.

2. General Requirements: (continued)

F. *Temperature rise* is the hot water temperature required by DPH Chapter 511-6-1 minus the temperature of the water coming into the food service establishment. For example, if the temperature of water entering a food service establishment is 40ºF and at least 100ºF hot water is needed at a handwashing sink, then the temperature rise would be 100ºF - 40ºF = 60ºF.

G. For *mechanical warewashing (i.e. chemical and hot water sanitizing warewashing),* a hot water demand shall be based on a primary rise (i.e. wash rinse) in temperature to 140ºF (60ºC). This is necessary due to the fact that chemical sanitizing warewashing machines rely on hot water coming directly from the food service establishment's hot water generation system to maintain its wash and rinse water temperature. Additionally, fresh rinse hot water sanitizing warewashers require an incoming hot water temperature of at least 140ºF (60ºC). This minimum incoming hot water temperature is necessary in order for booster heaters to function properly to deliver fresh hot water to the machines final rinse manifold at no less than the required 180°F (82°C) sanitization final rinse temperature.

H. For *hot water sanitizing mechanical warewashing*, an *external booster heater (see Illustration K-3 and K-8 for examples)* will be needed to boost the required gallons per hour demand an additional 40ºF (4ºC) to attain the required 180°F (82°C) sanitization fresh water final rinse temperature. It should be noted that some manufacturers equip some warewashers with an internal booster heater. If so equipped, internally installed booster heaters must deliver constant fresh water, final rinse at temperatures as required by DPH Rule 511-6-1-.05.

I. *Discretionary Hot Water Demand Reduction Criteria:*

a. *Storage-Tank Type Water Heating Systems*:

i. The Health Authority may allow *hot water demand reduction to be calculated for water saving devices* [4]used on hand operated pre-rinse sprayers, hand washing sinks and showers. Such hot water demand reductions must be supported by Manufacturer's flow rate for each device. The manufacturer's flow rate for each device is to be obtained from each device's specification documentation. The manufacturer's flow rate must be less than what is listed as follows:

I. *Hand operated pre-rinse sprayers* with flow rate *less than 3.5 GPM* standard flow rate;
II. *Hand washing sink faucet or aerator* with flow rate *less than 2.2 GPM* standard flow rate; and
III. *Shower head* with flow rate *less than 2.5 GPM* standard flow rate.

[4] Reference Source: Page 19, Food Establishment Specification Form, Tri-County Health Department, Greenwood Village, CO 8011 as reference from within student course materials of the most recent December 2012 Food and Drug Administration (FDA)'s Plan Review Course #FD207 given in Baton Rouge, LA.

2. General Requirements: I. Discretionary Hot Water Demand Reduction Criteria: (continued)

ii. *When calculating the hot water demand of warewashing sinks*[5], the Health Authority may allow a hot water demand reduction *based upon types of serving eating and drinking utensils* as follows:

I. For *food service establishments that utilize multi-use eating and drinking utensils*, the water heating system shall be sized to the capacity that will provide hot water at a rate equal to or greater than *100% of the computed warewashing sink and utensil soaking sink's hot water demand plus that of other equipment and fixtures utilizing hot water* ; and

II. For *food service establishments that use only single-service eating and drinking utensils*, the water heating system shall be sized to a capacity that will provide hot water at a rate equal to or greater than *80% of the computed warewashing sink's hot water demand plus that of other equipment and fixtures utilizing hot water*.

b. *On-Demand Water Heating Systems* - The Health Authority may allow *a hot water usage flow rate reduction in gallons per minute (GPM*[6]*)* to be used for low flow water fixtures installed on the following units of equipment as long as the manufacturer's specifications of these equipment is less than that shown in Table K-2:

i. 3-Compartmented Sinks
ii. Hand operated Pre-rinse Sprayers
iii. Food Preparation Sinks
iv. Handwashing Sinks
v. Showers
vi. Warewashing Machines - *Use manufacturer's flow rate in GPM for specific make and model of warewashing machines.*

J. *Water heaters that use reclaimed heat from equipment* to heat water must be evaluated on a case-by-case basis. The local Health Authority is advised to consult with the Department prior to approval of such systems.

K. *Hot water recirculation systems* must be considered when the water heater is over 60 feet from the farthest fixture served. In some cases, separate, smaller water heaters for remote fixtures, such as toilet room handwashing sinks may be more appropriate than a hot water recirculation system. *See Illustration K-4 Under-the-Sink Water Heating Alternative to Recirculation Systems.*

[5] Reference Source: Guidelines For Sizing Water Heaters – September, 1995 - as published by the "California Conference of Directors of Environmental Health" and recommended within Section III, Part 9 of the "2000 FDA Food Establishment Plan Review Guide" as published by the Food and Drug Administration and Conference for Food Protection.

[6] Reference Source: Page 20, Food Establishment Specification Form, Tri-County Health Department, Greenwood Village, CO 8011 as reference from within the current Food and Drug Administration (FDA)'s Plan Review Course #FD207.

3. Alternative Water Heating System Requirements:

A. *On-Demand (or Tankless) Water Heating Systems*[7]*-Background:* One of the advantages of a *tankless or on-demand water heater* [8]is its ability to provide a continuous supply of hot water on demand; thus, it costs less to operate than storage (or tank-type) water heaters. However, since the water passes through a heat exchanger, the water must flow through the unit slowly to assure proper heat transfer. Therefore and unless compensated in design, the quantity, or rate, at which the hot water is delivered, can be significantly less than that provided by a storage water heater. When hot water is utilized at several locations of the food service establishment at the same time, the flow of hot water to each fixture can be severely restricted. As a result of the restricted output of on-demand water heaters, more than one unit may be required, depending on the numbers and types of sinks and equipment present. See example operation in *Illustration K-5 On-Demand Water Heating Systems General Operation and Illustration K-6 Example: On-Demand Water Heating Systems Installed in Series.*

B. *Technology has changed significantly* over the past few years and now quite a few on-demand water heating systems are capable of delivering an endless supply of hot water at any temperature. However, these systems may be more expensive than tank-type water heaters. *See Illustration K-7 On-Demand Water Heating Systems vs. Storage (Tank-Type) Water Heating Systems.*

C. *On-Demand Water Heating Systems – Sizing and Installation Requirements*:

a. *General Design and Sizing Criteria*: Food service establishment plans and specifications that propose on-demand water heating systems must be prior approved by the Health Authority before its installation. If the on-demand water heater manufacturer has sizing, installation and system design criteria, then their criteria may be used as long as they have been previously submitted and approved by the local Health Authority. Otherwise, *use Table K-2* to calculate peak hot water demand. On-demand water heaters must be sized to provide hot water of a rate and at least temperatures as required by DPH Chapter 511-6-1 and they shall also be in compliance with all applicable Federal, State, and local building and plumbing code requirements. The design of on-demand hot water systems must be such that it is sized to meet the combined flow-rate in gpm of all fixtures and equipment utilizing hot water; be capable of maintaining the Chapter's target hot water demand temperatures at each fixture and equipment utilizing hot water; and be capable of maintaining satisfactory water flow, as determined by the Health Authority, at each fixture in order to provide enough agitation for cleaning purposes and to meet hot water utilizing, equipment manufacturer's flow rate specifications. Additionally, Proposed plans and specifications must accompanied by the following documentation:

[7] On-demand water heater - A water heater that generates hot water on demand.
[8] Reference Source: Guidelines For Sizing Water Heaters – September, 1995 - as published by the "California Conference of Directors of Environmental Health" and recommended within Section III, Part 9 of the "2000 FDA Food Establishment Plan Review Guide" as published by the Food and Drug Administration and Conference for Food Protection.

C. *On-Demand Water Heating Systems – Sizing and Installation Requirements*: a. General Design and Sizing Criteria: (continued)

i. Proposed on-demand water heater *sizing criteria specific to the combined flow-rate in gpm (gallons per minute) of the establishment's proposed or installed fixtures and equipment utilizing hot water; and the degree rise from incoming water temperature into the establishment and the target temperature to be delivered to each fixture and piece of equipment utilizing hot water;*

ii. *Tankless water heater's design specifications*; and

iii. The designer of the proposed on-demand hot water system must provide to the Health Authority a *written document certifying that the proposed design and installation will comply with what is specified within DPH Rule 511-6-1-.06(1)(g) 2.*

b. *Proposed experimental hot water generating technologies, such as the combining of on-demand water heating equipment technology with that of the standard storage tank technology,* must be submitted to the Department's Environmental Health Branch for review and comment prior to the proposed food service plans and specifications being approved for construction by the local Health Authority.

4. *Verifying Food Service Establishment Water Heating Systems*:

A. When *verifying the capacity of water heating systems*, *Work Sheet "A"* entitled, *"Storage Tank Type Water Heating Systems"* and *Work Sheet "B"* entitled, *"Tankless or On-Demand Water Heating Systems"* located within *Appendix-I* in Part-II of this Manual must be utilized to verify the proper sizing of a food service establishment's water heating system. the Planner and the Reviewer are advised to consult with DPH 511-6-1 and its Manual for Design, Installation and Construction, as referenced in *DPH Rule 511-6-1-.02(7).* Additionally, Work Sheet "A" and as needed Work Sheet "B" must be *completed by the planner*. Upon submittal to the local Health Authority, *these documents must be verified by the reviewer and retained within the proposed food service establishment inspection record file*.

B. *Work Sheets "A" and "B" are to be maintained by the local Health Authority* in the county in which the proposed food service establishment is to be constructed. They will remain as part of the proposed food service establishment's plan review and inspection record *until they are replaced as a result of a change in the permit holder or a major remodel of the establishment.*

II. Storage Tank Water Heaters Evaluation and Verification:

1. *Determining hot water needs of a food service establishment* is calculated by adding together all of the energy requirements for each fixture using hot water. For these calculations, it is generally assumed that the temperature of incoming water to the food service establishment is 40ºF unless specific data is provided by the permit applicant. Additionally, it must be noted that one gallon of water equals 8.33 lbs.[9] and that a British Thermal Unit (BTU) is the amount of heat energy needed to raise the temperature of one pound of water by one degree F. Therefore, 8.33 lbs. is equal to 8.33 BTUs of energy needed to heat one gallon of water one degree Fahrenheit. This is the standard measurement used to state the amount of energy that a fuel has as well as the amount of output of any heat generating device. As such, it is necessary to calculate *both the demand for hot water in gallons per hour (GPH) and the temperature rise needed for each piece of equipment as required by the manufacturer and the Chapter*. This information can then be converted to BTU's (British Thermal Units) or KW (Kilowatts), the energy demand for each fixture and piece of equipment specified within the plans. *The capacity of the water heater* will then be determined by adding up the individual BTU or KW energy demand requirements for each fixture and piece of equipment utilizing hot water. Additionally, when sizing tank type water heaters, the concern is how much energy is necessary to maintain a volume (or mass) of hot water at a required temperature to meet the peak demand of equipment and fixtures within the establishment.

2. For purposes of calculating GPH in determining BTU and/or KW for each piece of equipment to *determine water heating equipment capacity*, the following shall apply:

   A. Handwashing Sinks (including restrooms)* = *5 GPH X number of handsinks to be installed*

   B. Manual Warewashing Sinks and Utensil Soak Sinks hot water demand in GPH:

   Warewashing Sink/
   Utensil Soak Sink GPH = *sink compartment size (inch^3) X # of compartments X .003255 inch^3 per gallon X number of units to be installed.*

   Note: *See Illustration K-1 for more information.*
   Note: *.003255 inch^3/gallon provides a 75% compartment fill to compensate for mass of utensils and equipment.*
   Note: *If single-service eating and drinking utensils are proposed, use 80% of the computed warewashing sink's volume capacity.*
   Note: *Peak Hot Water Demand may be substituted by calculated values for Water Saving Devices – See example calculations to follow.*

   C. Food preparation sinks hot water demand in gph:

   Preparation sink gph = 5 GPH X number of compartments X number of units to be installed

[9] Note: lbs (pounds) in 8.33 lbs/gallon is silent in the resulting figure for BTU's and KW's

* Hot water demand reduction as per calculations in subsection II 3 of this Section.

D. Warewashing Machine hot water demand = *70% of "final rinse usage" found on unit's manufacturer's specification sheet (cut sheet) X number of units to be installed*

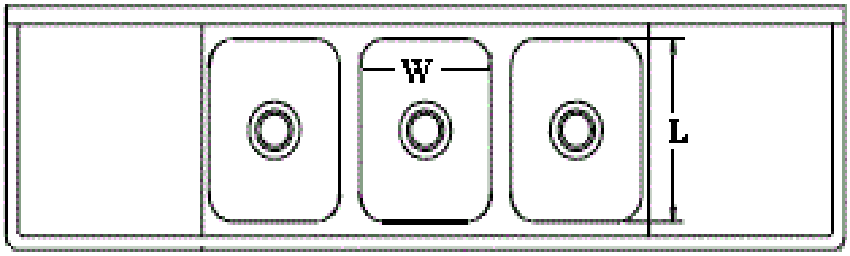
E. Warewashing Machine Conveyor Pre-rinse = *Use manufacturer's flow rate in GPH for specific make and model of warewashing machine*

F. Hand Operated Pre-rinse Spray* hot water demand in GPH= *45 GPH X number of units to be installed*

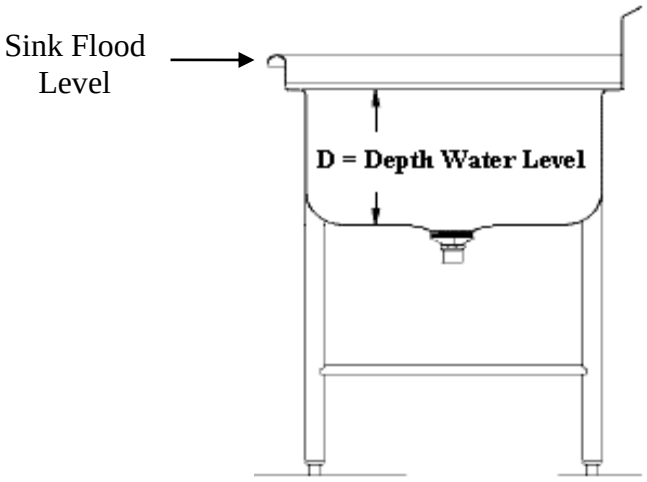
G. Hose Reels = *10 GPH X number of units to be installed*

Illustration K-1
Measuring the Volume of Vats of a Compartmented Sink

Top View Looking Down



L = Length of Compartment in Inches
W = Width of Compartment in Inches



Notes:

Take measurements from inside the compartment.

Volume of One Vat = Length (L) inches × Width (W) inches × Depth (D) inches = Cubic Inches

2. (Continued):

Cubic Inches × Number of Vats (or Compartments) = Combined Volume of Compartmented Sink in Cubic Inches

Combined Volume of Compartmented Sink in Cubic Inches × .003255 Cubic Inches per Gallon = Total Volume of Compartmented Sink in Gallons

Conversion Factor (.003255 in^3/gallon) = Overall 75% reduction of hot water usage allowance for equipment and utensils submerged within vats.

H. Hose Bibb used for cleaning = *35 GPH*

I. Shower* = 35 *GPH X number of units to be installed*

J. Other = Manufacturer's Specification Sheets

K. * A hot water demand reduction may be calculated for water saving devices used on hand operated pre-rinse sprayers, handwashing sinks and showers by utilizing the calculations in 3. Calculations - A. Water Saving Devices.

3. *Calculations*:

A. *Water Saving Devices*[10]:

a. Obtain manufacturer's flow rate for each device. The manufacturer's flow rate must be less than what is listed below to be considered:

i. Hand operated pre-rinse sprayers with flow rate less than 3.5 GPM standard flow rate.

Manufacturer: _____; Model#: _____

Manufacturer's Flow Rating: _____ GPM

ii. Handwashing sink faucet or aerator with flow rate less than 2.2 GPM standard flow rate.

Manufacturer: _____; Model#: _____

Manufacturer's Flow Rating: _____ GPM

[10] Reference Source: Pages 18 and 19, Food Establishment Specification Form, Tri-County Health Department, Greenwood Village, CO 8011 as reference from within student course materials of the current Food and Drug Administration (FDA)'s Plan Review Course #FD207.

iii. Shower head with flow rate less than 2.5 GPM standard flow rate.

Manufacturer: _____; Model#: _____

Manufacturer's Flow Rating: _____ GPM

3. Calculations: A. Water Saving Devices: (Continued)

b. Use the following equation to determine the *reduced hourly hot water demand* for each of the three types of fixtures listed above:

$$(A \times B) \div C = D,$$ where:

A = *Manufacturer's Flow Rate*
B = *Water use value from Table K-1 to calculate Peak Hourly Hot Water Demand Per Type of Fixture (gallons per hour or GPH)*
C = *GPM standard flow rate*
D = *New water use value to substitute for that given in Table K-1 to calculate Peak Hourly Hot Water Demand Per Type of Fixture (gallons per hour or GPH)*

For example:

A handwashing sink that has an aerator with a *manufacturer's flow rate of 0.5*:

Manufacturer: Watts; Model #: 66B
Manufacturer's Flow Rate: *0.5 GPM*

Where:

A = *0.5 GPM*;
B = *5 GPH*;
C = *2.2 GPM*;
D = the New Value to substitute that in Table K-1 to calculate Peak Hourly Hot Water Demand Per Type of Fixture (gallons per hour or GPH); and
A = *0.5 GPM is less than the 2.2 GPM standard flow rate given in statement 3 A a ii above.*

(0.5 GPM × 5 GPH) ÷ 2.2 GPM = 1.14 GPH

Therefore, in Table K-1, *the 5 GPH value* for the Handwashing Sinks (including restrooms) would be *replaced with 1.14 GPH* as the value to calculate the Peak Hourly Hot Water Demand for all Handwashing Sinks located within the establishment.

B. *Peak Hourly Hot Water Demand:* The following Table K-1 "Peak Hourly Hot Water Demand in GPH" is to be used to calculate the maximum hourly demand per each type of fixture or equipment to be installed. These figures will be used to calculate the BTU or KW capacity of the water heating equipment:

Table K-1 - Peak Hourly Hot Water Demand Per Fixture in Gallons Per Hour[11]

Units		**Peak Hourly Hot Water Demand in GPH**
Food Preparation Sink Compartments	=	5 GPH (*each)*
Handwashing Sinks (including toilet rooms)*	=	5 GPH
Mop/Utility Sinks	=	10 GPH
Clothes Washer	=	15 GPH
Hose Reel[12]	=	10 GPH
Hose Bibb used for cleaning	=	35 GPH
Hand Operated Pre-rinse Spray[13]*	=	45 GPH
Warewashing Machine Conveyor Pre-rinse†	=	Manufacturer Specification Sheets
Showers*	=	14 GPH
Other	=	Manufacturer Specification Sheets

Warewashing sinks & Utensil Soak Sinks GPH = sink comp. size inch^3 X # of compt. X .003255 inch^3/gallon*

Note[1]: .003255 inch^3/gallon provides a 75% compartment fill to compensate for mass of utensils and equipment.
Note[2]: If single-service eating and drinking utensils, *use 80% of the computed warewashing sink or utensil soak sink's volume capacity*.
Note[3:] Formula for all compartmented sinks used to submerge equipment and utensils as part of the cleaning and/or sanitizing process.

Mechanical warewashing machine GPH = 70% of "final rinse usage" found on manufacturer's specification sheet (i.e. cut sheet)

† Use manufacturer's flow rate in GPH for specific make and model of warewashing machine.

* A hot water demand reduction may be calculated for water saving devices used on hand operated pre-rinse sprayers, handwashing sinks and showers by utilizing the calculations in subsection 3 A "Water Saving Devices".

[11] Source: Page 40, Section 5 – WATER SUPPLY AND SEWAGE DISPOSAL – current 2008 FDA Plan Review for Food Establishments guidance document and Page 18, Food Establishment Specification Form, Tri-County Health Department, Greenwood Village, CO 8011 as reference from within the current Food and Drug Administration (FDA)'s Plan Review Course #FD207.
[12] See Illustration K-3 for an example of Hose Reel.
[13] See Illustration K-3 for an example of a Hand Operated Pre-rinse Spray.

D. *"Restaurant A" Example Calculations for BTU's and KW's*[14]: Once GPH has been calculated for each piece of equipment and fixture utilizing hot water, the BTU, if gas fired water heater, or KW, if electric water heater, must be calculated to determine the required capacity for the establishment's water heating equipment. See the following examples:

Formula to calculate the BTU's needed for gas hot water heaters:

$$\text{Required BTU's} = \frac{\text{Gallons per hour of water X Temperature rise X 8.33 Pounds per gallon}}{\text{.75 (Operating efficiency)*}}$$

**Note: Use manufacturer's equipment efficiency rating, if available.*

Formula to calculate the KW's needed for electric hot water heaters:

$$\text{Required KW's} = \frac{\text{Gallons per hour of water X Temperature rise X 8.33 Pounds per gallon}}{\text{3412 (BTU's per KW)}}$$

E. *Determining Tank Water Heater Capacity*: Once either BTU's or KW's have been calculated for each piece of equipment and fixture utilizing hot water, the BTU, if gas fired water heater, or KW, if electric water heater, must be added together to determine the required capacity for the establishment's water heating equipment.

F. *Common Mistakes With Sizing Electric Water Heaters*[15]: A common mistake with electric water heaters is 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 observe the total connected wattage and assume that because each of the elements is 4500 watts their water heater has an input rating of 9000[16] 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. Prior to acceptance of a field modified water heater, the local health agency should ensure that the modifications were performed according to the manufacturer's recommendations and with the approval of the local building officials. The data plate on a field modified water heater must be changed to reflect the total connected wattage rating with both elements operating simultaneously.

[14] Source: Page 50 in Section 5 – WATER SUPPLY AND SEWAGE DISPOSAL – 2008 FDA Plan Review for Food Establishments guidance document.
[15] Most residential water heaters fall within this criteria.
[16] 9000 watts is equal to 9 KW (1KW = 1000 watts)

G. *Example Calculations:* Two food service plan review requests are received by the local Health Authority. Upon examination of food service plans and specifications for "Restaurant A", the Reviewer takes note of the proposed units of fixtures and equipment to be installed. Within specifications noted within the plans, it is discovered that a warewashing machine will be used to support the use of multi-use eating and drinking utensils and that water saving devices will not be installed on fixtures. However, review of the plans and specifications for "Restaurant B" reveal a different scenario. They are similar to that of "Restaurant A" but, they do not include the warewashing machine. Another variation from "Restaurant A"'s plans and specifications is that "Restaurant B" plans and specifications also specify water saving devices to be installed on all handwashing sinks, hand operated pre-rinse sprays, and two shower heads – one male and one female. Additionally, the plans noted that "Restaurant B" will be using all single-service eating and drinking utensils. Using Table K-1 , calculate the peak demand in gallons per hour (GPH) for each unit of fixture and equipment for each proposed set of plans and specifications for "Restaurant A" and "Restaurant B":

***"Restaurant A" Water Heater Sizing Verification*:**

Step #1: Determine the maximum hourly hot water demand for each type of fixture in gallons per hour *(or MHHWDTF-GPH)* by using peak hourly hot water demand values for each fixture and equipment from Table K-1 on page K10:

Chart K-1 "Restaurant A"
Maximum Hourly Hot Water Demand Per Type of Fixture in Gallon Per Hour
Or (MHHWDTF-GPH)

Units	# of Units		Peak Hourly Hot Water Demand in GPH		***MHHWDTF-GPH***
Three-Comp. Warewashing Sink	1	×	24 × 24 × 14 (***Note #1***)	=	***79***
Two-Comp. Food Preparation Sink	2	×	10 GPH (2 × 5 GPH)	=	*20*
Handwashing Sinks (including restrooms)	5	×	5 GPH	=	*25*
Hand Operated Pre-rinse Spray	1	×	45 GPH	=	*45*
Warewashing Machine	1	×	***Note #2***	=	***52***
Mop/Utility Sink	1	×	10 GPH	=	*10*
Clothes Washer	1	×	15 GPH	=	*15*
Hose Reel	2	×	10 GPH	=	*20*

Note #1:
Warewashing Sink GPH = sink compartment size (inch^3) × # of compartments × .003255 inch^3 (cubic inches) per gallon × number of units to be installed.
Compartment measurement = Length × Width × Depth = volume in cubic inches

GPH = (24" × 24" × 14") × 3 compartments × .003255 inch^3 per gallon × 1 unit = ***79 GPH***

Note #2:
Warewashing Machine – Hobart AM-14 *Final Rinse GPH = 74*
GPH = *74 GPH Final Rinse* (from manufacturer cut sheet) × *70% (or .70)* = 51.8 (or ***52 GPH***)

Step #2: Calculate BTU's and KW's[17] using *MHHWDTF-GPH Chart K-1calculated in Step #1*:

Equipment	MHHWDTF-GPH Demand from Chart K-1	Temperature Required	Temperature Rise
3 – Comp. Warewashing sink	**79**	110ºF	110ºF - 40ºF = 70ºF

79 (gph) X 70ºF temperature rise X 8.33 = *61,419.87 ~ 61,420 BTU's*
.75 (operating efficiency)

79 (gph) X 70ºF temperature rise X 8.33 = 13.500 ~ *14.0 KW's*
3412 (BTU's per KW)

****

Equipment	MHHWDTF-GPH Demand from Chart K-1	Temperature Required	Temperature Rise
Hand sink	25	100ºF	100ºF - 40ºF = 60ºF

25 (gph) X 60ºF temperature rise X 8.33 = *16,660 BTU's*
.75 (operating efficiency)

25 (gph) X 60ºF temperature rise X 8.33 = 3.662 ~ *4.0 KW's*
3412 (BTU's per KW)

****

Equipment	MHHWDTF-GPH Demand from Chart K-1	Temperature Required	Temperature Rise
Two comp. Prep Sink	20 = (2 X 5 gph = 10gph) X 2	110ºF	110ºF - 40ºF = 70ºF

20 (gph) X 70ºF temperature rise X 8.33 = *15,549 BTU's*
.75 (operating efficiency)

20 (gph) X 70ºF temperature rise X 8.33 = 3.417 ~ *3.42 KW's*
3412 (BTU's per KW)

[17] Source: Page 50 in Section 5 – WATER SUPPLY AND SEWAGE DISPOSAL – 2008 FDA Plan Review for Food Establishments guidance document.

Step #2: Calculate BTU's and KW's using *MHHWDTF-GPH Chart K-1 calculated in Step #1*: (Continued)

Equipment	MHHWDTF-GPH Demand from Chart K-1	Temperature Required	Temperature Rise
Pre-rinse Spray	45	110ºF	110ºF - 40ºF = 70ºF

45 (gph) X 70ºF temperature rise X 8.33 = *34,986 BTU's*
.75 (operating efficiency)

45 (gph) X 70ºF temperature rise X 8.33 = 7.690 ~ *8.0 KW's*
3412 (BTU's per KW)

****

Equipment	MHHWDTF-GPH Demand from Chart K-1	Temperature Required	Temperature Rise
Fresh Hot Water Mechanical Warewashing Machine	**52**	140ºF	140ºF - 40ºF = 100ºF

52 (gph) X 100ºF temperature rise X 8.33 = *57,755 BTU's*
.75 (operating efficiency)

52 (gph) X 100ºF temperature rise X 8.33 = 12.695 ~ *13.0 KW's*
3412 (BTU's per KW)

****

Equipment	MHHWDTF-GPH Demand from Chart K-1	Temperature Required	Temperature Rise
Mop Sink	10	110ºF	110ºF - 40ºF = 70ºF

10 (gph) X 70ºF temperature rise X 8.33 = *7,774 BTU's*
.75 (operating efficiency)

10 (gph) X 70ºF temperature rise X 8.33 = 1.708 ~ *2.0 KW's*
3412 (BTU's per KW)

Step #2: Calculate BTU's and KW's using *MHHWDTF-GPH Chart K-1 calculated in Step #1*: (Continued)

Equipment	MHHWDTF-GPH Demand from Chart K-1	Temperature Required	Temperature Rise
Clothes Washer	15	110ºF	110ºF - 40ºF = 70ºF

15 (gph) X 70ºF temperature rise X 8.33 = *11,662 BTU's*
.75 (operating efficiency)

15 (gph) X 70ºF temperature rise X 8.33 = 2.563 ~ *3.0 KW's*
3412 (BTU's per KW)

****

Equipment	MHHWDTF-GPH Demand from Chart K-1	Temperature Required	Temperature Rise
Hose Reel	20 = 2 X 10 gph	110ºF	110ºF - 40ºF = 70ºF

20 (gph) X 70ºF temperature rise X 8.33 = *15,549 BTU's*
.75 (operating efficiency)

20 (gph) X 70ºF temperature rise X 8.33 = 3.417~ *3.42 KW's*
3412 (BTU's per KW)

****

Equipment	MHHWDTF-GPH Demand from Chart K-1	Temperature Required	Temperature Rise
Booster Heater[18]	**52**	180ºF	180ºF - 140ºF = 40ºF

52 (gph) X 40ºF temperature rise X 8.33 = 23,101.87 ~ *23,102 BTU's*
.75 (operating efficiency)

52 (gph) X 40ºF temperature rise X 8.33 = 5.078~ *5.1 KW's*
3412 (BTU's per KW)

[18] A booster heater must be provided and sized to supply an additional *23,102 BTU's or 5.1 KW's* in order to achieve the minimum 180ºF at the final fresh hot water rinse manifold.

Step #3: Determine Tank Water Heater Capacity

Chart K-2 - Tank Water Heater Capacity from Step #2

Unit	BTU's	KW's
3-Comp. Warewashing Sink----------	61,420	14.00
Hand Sink----------	16,660	4.00
2-Comp. Prep. Sink----------	15,549	3.42
Pre-rinse Spray----------	34,986	8.00
Chemical/Mechanical Warewashing Machine------	57,755	13.00
Mop Sink----------	7,774	2.00
Clothes Washer----------	11,662	3.00
Hose Reel----------	15,549	3.42
REQUIRED WATER HEATER CAPACITY =	***221,355***	***50.84***

Conclusion: From totals calculated in Chart K-2, a water heater with the BTU rating (or capacity) *of 221,355 BTU's, if gas fired*, or one with a KW rating (or capacity) of *50.84 ~ 51 KW's, if electric*, will be required in order to meet the peek hot water demand of the proposed food service establishment. In addition, a booster heater for the hot water sanitizing, warewashing machine must be provided and sized to supply an additional *23,102 BTU's or 5.1 KW's*. The booster heater is necessary in order to boost the required gallons per hour demand an additional 40°F to attain the required minimum 180°F final rinse temperature. *See Illustration K-8 Booster Heater General Operation.*

***"Restaurant B" Water Heater Sizing Verification*:**

Step #1, *Water Saving Device Reductions*: Determine hot water reductions allowable for fixtures listed in 3 A Water Saving Devices on page K8 of this Section:

A. Obtain manufacturer's flow rate for each device. The manufacturer's flow rate must be less than what is listed below to be considered:

- Hand operated pre-rinse sprayers with flow rate less than 3.5 GPM standard flow rate.

  Manufacturer: Delta Model#: M42A

  Manufacturer's Flow Rating: *2.2 GPM*

- Handwashing sink faucet or aerator with flow rate less than 2.2 GPM standard flow rate.

  Manufacturer: Delta; Model#: D46420Z

  Manufacturer's Flow Rating: *1.5 GPM*

- Shower head with flow rate less than 2.5 GPM standard flow rate.

  Manufacturer: Monet; Model#: Z120E

  Manufacturer's Flow Rating: *2.0 GPM*

B. Using the following equation, the *reduction in the hourly hot water demand* for each of the three types of fixtures listed above is determined by the following calculations:

$$(A \times B) \div C = D, \text{ where:}$$

A = *Manufacturer's Flow Rate*
B = *Water use value from Table K-1 to calculate Peak Hourly Hot Water Demand Per Type of Fixture (gallons per hour or GPH)*
C = *GPM standard flow rate*
D = *New water use value to substitute for that given in Table K-1 to calculate Peak Hourly Hot Water Demand Per Type of Fixture (gallons per hour or GPH)*

Hand Operated Pre-rinse Spray with flow rate = 2.2 GPM:

Use Formula *(A × B) ÷ C = D* where:

A = *2.2 GPM*;
B = *45 GPH*;
C = *3.5 GPM*;
D = the New Value to substitute that in Table K-1 to calculate Peak Hourly Hot Water Demand Per Type of Fixture (gallons per hour or GPH); and
A = 2.2 *GPM is less than the 3.5 GPM standard flow rate given A above.*

New Peak Hourly Demand in GPH to substitute the value for Hand Operated Pre-rinse Sprays in Table K-1is (2.2 GPM ×4 5 GPH) ÷ 3.5 GPM = 28.3 GPH

Handwashing sink faucet or aerator with flow rate = 1.5 GPM

Use Formula *(A × B) ÷ C = D* where:

A = 1.5 *GPM*;
B = *5 GPH*;
C = *2.2 GPM*;
D = the New Value to substitute that in Table K-1 to calculate Peak Hourly Hot Water Demand Per Type of Fixture (gallons per hour or GPH); and
A = 1.5 *GPM is less than the 2.2 GPM standard flow rate given A above.*

New Peak Hourly Demand in GPH to substitute the value for Hand Operated Pre-rinse Sprays in Table K-1is (1.5 GPM × 5 GPH) ÷ 2.2 GPM = 3.41 GPH

Shower head with flow rate = 2.0 GPM

Use Formula *(A × B) ÷ C = D* where:

A = 2.0 *GPM*;
B = *14 GPH*;
C = *2.5 GPM*;
D = the New Value to substitute that in Table K-1 on page K10 to calculate Peak Hourly Hot Water Demand Per Type of Fixture (gallons per hour or GPH); and
A = 2.0 *GPM is less than the 2.5 GPM standard flow rate given A above.*

New Peak Hourly Demand in GPH to substitute the value for Hand Operated Pre-rinse Sprays in Table K-1 on page K10 is (2.0 GPM × 14 GPH) ÷ 2.5 GPM = 11.2 GPH

Step #2: Determine the maximum hourly hot water demand for each type of fixture in gallons per hour *(or MHHWDTF-GPH)* by using peak hourly demand values for each fixture and equipment. *See Table K-1* on page K10 in this Section as a reference:

Chart K-3 "Restaurant B"
Maximum Hourly Hot Water Demand Per Type of Fixture in Gallon Per Hour
Or (MHHWDTF-GPH)

Units	# of Units		Peak Hourly Hot Water Demand in GPH		***MHHWDTF-GPH***
Three-Comp. Warewashing Sink	1	×	24 × 24 × 14 (***Note #1***)	=	***63.2****
Two-Comp. Food Preparation Sink	2	×	10 GPH (2 × 5 GPH)	=	20
Handwashing Sinks* (including restrooms)	5	×	***3.41 GPH****	=	***17.05***
Hand Operated Pre-rinse Spray*	1	×	***28.3 GPH****	=	**28.3**
Mop/Utility Sink	1	×	10 GPH	=	10
Clothes Washer	1	×	15 GPH	=	15
Hose Reel	2	×	10 GPH	=	20
Shower*	2	×	***11.2 GPH****	=	**22.4**

Note #1:
Warewashing Sink GPH = sink compartment size (inch^3) × # of compartments × .003255 inch^3 (cubic inches) per gallon × number of units to be installed.
Compartment measurement = Length × Width × Depth = volume in cubic inches

GPH = (24" × 24" × 14") × 3 compartments × .003255 inch^3 per gallon × 1 unit = *79 GPH*
*Because *single-service eating and drinking utensils will be utilized*, 80% of 79 GPH will be used for MHHWDTF: 79 GPH × 80% (or .80) = ***63.2 GPH****

* Substitute Peak Hourly Hot Water Demand values calculated in Step #1for Water Saving Devices.

Step #3: Calculate BTU's and KW's[19] using *MHHWDTF-GPH Chart K-3 calculated in Step #2*:

Equipment	MHHWDTF-GPH Demand from Chart K-3	Temperature Required	Temperature Rise
3 – Comp. Warewashing sink	***63.2***	110ºF	110ºF - 40ºF = 70ºF

63.2 (gph) X 70ºF temperature rise X 8.33 = 49,135.89 ~ *49,136 BTU's*
.75 (operating efficiency)

63.2 (gph) X 70ºF temperature rise X 8.33 = 10.800 ~ *11 KW's*
3412 (BTU's per KW)

[19] Source: Page 50 in Section 5 – WATER SUPPLY AND SEWAGE DISPOSAL – 2008 FDA Plan Review for Food Establishments guidance document.

Step #2: Calculate BTU's and KW's using *MHHWDTF-GPH Chart K-3 calculated in Step #1*: (Continued)

Equipment	MHHWDTF-GPH Demand from Chart K-3	Temperature Required	Temperature Rise
Hand sink	***17.05***	100ºF	100ºF - 40ºF = 60ºF

17.05 (gph) X 60ºF temperature rise X 8.33 = *11,362 BTU's*
.75 (operating efficiency)

17.05 (gph) X 60ºF temperature rise X 8.33 = 2.495 ~ *2.5 KW's*
3412 (BTU's per KW)

****

Equipment	MHHWDTF-GPH Demand from Chart K-3	Temperature Required	Temperature Rise
Two comp. Prep Sink	20 = (2 X 5 gph = 10gph) X 2	110ºF	110ºF - 40ºF = 70ºF

20 (gph) X 70ºF temperature rise X 8.33 = *15,549 BTU's*
.75 (operating efficiency)

20 (gph) X 70ºF temperature rise X 8.33 = 3.417 ~ *3.42 KW's*
3412 (BTU's per KW)

****

Equipment	MHHWDTF-GPH Demand from Chart K-3	Temperature Required	Temperature Rise
Hand Operated Pre-rinse Spray	***28.3***	110ºF	110ºF - 40ºF = 70ºF

28.3 (gph) X 70ºF temperature rise X 8.33 = *22,002 BTU's*
.75 (operating efficiency)

28.3 (gph) X 70ºF temperature rise X 8.33 = 4.836 ~ *5.0 KW's*
3412 (BTU's per KW)

Step #2: Calculate BTU's and KW's using *MHHWDTF-GPH Chart K-3 calculated in Step #1*: (Continued)

Equipment	MHHWDTF-GPH Demand from Chart K-3	Temperature Required	Temperature Rise
Mop Sink	10	110ºF	110ºF - 40ºF = 70ºF

10 (gph) X 70ºF temperature rise X 8.33 = 7,774.66 ~ *7,775 BTU's*
.75 (operating efficiency)

10 (gph) X 70ºF temperature rise X 8.33 = 1.708 ~ *2.0 KW's*
3412 (BTU's per KW)

****

Equipment	MHHWDTF-GPH Demand from Chart K-3	Temperature Required	Temperature Rise
Clothes Washer	15	110ºF	110ºF - 40ºF = 70ºF

15 (gph) X 70ºF temperature rise X 8.33 = *11,662 BTU's*
.75 (operating efficiency)

15 (gph) X 70ºF temperature rise X 8.33 = 2.563 ~ *3.0 KW's*
3412 (BTU's per KW)

****

Equipment	MHHWDTF-GPH Demand from Chart K-3	Temperature Required	Temperature Rise
Hose Reel	20 = 2 X 10 gph	110ºF	110ºF - 40ºF = 70ºF

20 (gph) X 70ºF temperature rise X 8.33 = *15,549 BTU's*
.75 (operating efficiency)

20 (gph) X 70ºF temperature rise X 8.33 = 3.417~ *3.42 KW's*
3412 (BTU's per KW)

Step #2: Calculate BTU's and KW's using *MHHWDTF-GPH Chart K-3 calculated in Step #1*: (Continued)

Equipment	MHHWDTF-GPH Demand from Chart K-3	Temperature Required	Temperature Rise
Shower Head	***22.4*** = 2 X 11.2 gph	120ºF	120ºF - 40ºF = 80ºF

22.4 (gph) X 80ºF temperature rise X 8.33 = *19,903.15* ~ *19,903 BTU's*
.75 (operating efficiency)

22.4 (gph) X 80ºF temperature rise X 8.33 = 4.374~ *4.4 KW's*
3412 (BTU's per KW)

Step #4: Determine Tank Water Heater Capacity

Chart K-4 - Tank Water Heater Capacity from Step #2

Unit	BTU's	KW's
3-Comp. Warewashing Sink----------	***49,136***	***11.00***
Hand Sink----------	***11,362***	***2.50***
2-Comp. Prep. Sink----------	15,549	3.42
Hand Operated Pre-rinse Spray----------	***22,002***	***5.00***
Mop Sink----------	7,775	2.00
Clothes Washer----------	11,662	3.00
Hose Reel----------	15,549	3.42
Shower ----------	***19,903***	***4.40***
REQUIRED WATER HEATER CAPACITY =	***152,938***	***34.74***

Conclusion: From totals calculated in Chart K-4, a water heater with the BTU rating (or capacity) of *152,938* BTU's, if gas fired, or one with a KW rating (or capacity) of *34.74* KW's, if electric, will be required in order to meet the peek hot water demand of the proposed food service establishment. Because single-service eating and drinking articles will be utilized during service, a warewashing machine will not be necessary and likewise, the volume of hot water demand for manual warewashing will be reduced as well. Hot water demand is further reduced with the addition of water saving devices installed on handwashing sinks, hand operated pre-rinse sprays, and shower heads.

III. On-Demand (Tankless) Water Heating System Evaluation and Verification:

1. *Calculate the Total Hot Water Demand Flow Rate in Gallons Per Minute (GPM)*: If the heater manufacturer has sizing, installation and system design criteria, then their criteria may be used as long as they have been previously submitted and approved by the local Health Authority in consultation with the Department. Otherwise, use the following Table K-2 to calculate peak hot water demand:

Table K-2 Total Hot Water Demand Flow Rate

Plumbing Fixture	Hot Water Usage (gallons per minute)	Number of Fixtures	Hot Water Demand Flow Rate in Gallons Per Minute
Example: Warewashing Machine †Hobart AM14	8.0	1	(8.0 × 1) = 8.0
Example: Handsink(s)	0.5	4	(0.5 × 4) = 2.0
3-Compartment Warewashing Sink*	2.0 for each faucet		
3-Compartment Bar Sink*	2.0 for each faucet		
Utensil Soak Sink	1.0		
Warewashing Machine†			
Warewashing Machine Conveyor Pre-rinse†			
Clothes Washer	2.0		
Hand Operated Pre-rinse Sprayer*	2.0		
Food Preparation Sink(s)*	1.0		
Handwashing Sinks (including restrooms)*	0.5		
Mop/Utility Sinks	2.0		
Garbage Can Washers	1.0		
Shower Heads*	1.0		
Hose Bibb used for cleaning	5.0		
Total Hot Water Demand Flow Rate (GPM) Required:			

* A flow rate reduction may be used for low flow water faucets installed on 3-compartment sinks, hand operated pre-rinse sprayers, food preparation sinks, handwashing sinks and shower heads by entering the manufacturer's flow rate listed for the faucet or faucet's aerator. Flow rate reductions may be applied if manufacturer's flow rates are less than those shown above.

† Use manufacturer's flow rate in GPM for specific make and model of warewashing machine.

2. *Calculate the maximum hot water flow rate for the establishment*: The thermal efficiency of the water heating units must be adjusted for altitude. The altitude adjustment is *4% per 1000 feet of elevation above sea level, or 20% at 5000 feet above sea level.* The designer of the on-site demand water heating system will need to provide altitude data for the site of the proposed food service establishment to be used in the following calculations:

   Use the following equation to *determine the establishment's maximum flow rate in GPM:*

   (0.04 × _____ ÷ 1000) + 1 = _____
   Elevation of facility adjustment factor

   _____ × _____ = _____
   Adjustment factor | total hot water demand flow rate calculated in Table K-2 page K23 | maximum GPM hot water flow usage

   Use calculated maximum GPM hot water flow usage value in this equation to determine the minimum number of heating units that will be required as determined from the equation in "3" below.

3. *Determine the number of heating units* that will be needed to meet the required maximum hot water flow rate for the establishment:

   _____ ÷ _____ = _____
   Maximum GPM hot water Flow usage calculated in "2" above | manufacturer's flow rate in GPM @100°F or 80°F rise** | number of heating units required*

   *Multiple units must be installed and plumbed to operate in a parallel configuration.
   **If there are no high temperature dishwashing machine or other fixtures requiring input water temperatures of 140°F (100°F rise) or more, then 80°F rise can be used.

4. *Storage Tank Sizing*: If a warewashing machine(s) is to be installed, the on-demand water heating system must include a storage tank to eliminate lag in availability of hot water at the warewashing machine. If not, the effects of water temperature lag between start-up time of the unit and the point when hot water is received at the warewashing machine will cause warewashing machines to operate outside of their designed operating parameters. As a result, eating and drinking utensils and equipment placed within them will not be properly cleaned and sanitized as required by DPH Rule 511-6-1-.05. Therefore, the storage tank must be at least 25 gallons or at least 25% of the gallons per hour (GPH) demand of the warewashing machine(s). The larger value of the two is the required storage tank size. Use the following equations to calculate on-demand water heating system storage tanks:

Dishwashing Machine*

Manufacturer: _____ Model Number: _____
Gallons Per Hour Water Consumption: _____ × 0.25 = _____
Storage tank capacity in gallons
Calculated Storage Tank Capacity: _____ vs. 25 Gallon Storage Tank
Enter the larger of the two: _____ Required Storage Tank Capacity**

* High temperature, heat sanitizing warewashing machines must be provided with a separate booster heater. Use of an instantaneous unit is not allowed for use as a booster heater.

** The storage tank must be installed in the hot water supply line located between the heater unit(s) and the hot water distribution line. A recirculation line and aquastat (water thermostat) must be installed at the storage tank to assure the water in the tank remains at the appropriate temperature (120°F to 140°F). The recirculation line must be connected between the storage tank and the cold water supply line at the heater unit(s).

5. *Example Calculations:* A food service plan review requests was received by the local Health Authority. Upon examination of the submitted food service plans and specifications for "Restaurant X", the Reviewer takes note of the proposed units of fixtures and equipment to be installed. Within specifications noted on the plans, it is discovered that a warewashing machine will be used to support the use of multi-use eating and drinking utensils. In addition, low flow water faucets will be installed on a 3-compartmented warewashing sink, a hand operated pre-rinse sprayer, food preparation sinks, handwashing sinks and showers. Further examination of manufacturer's specification sheets revealed the following flow rates:

Manufacturer's Specifications "Restaurant X"

Unit of Equipment or Fixture	Gallons Per Minute
3-Compartmented Warewashing Sink & Bar Sink	1.5 @ faucet
Warewashing Machine Hobart AM-14	8.0
Hand Operated Pre-rinse Spray	1.0 @ spray
Food Preparation Sink	0.5 @ faucet
Handwashing Sink (including restrooms)	0.4 @ faucet
Mop/Utility Sink	1.0 @ faucet
Showers	0.5 @ shower head

Using the manufacturer's specifications for "Restaurant X" and Table K-2 Hot Water Demand Flow Rate, calculate the required total hot water demand flow rate or "Restaurant X":

Step #1; Calculate Total Hot Water Demand in Gallons Per Minute:

Note: Substitute the Manufacturer's Specifications for flow rates for fixtures and equipment for that given in Table K-2 on page K23 of this Section.

Chart K-5 Total Hot Water Demand Flow Rate

Plumbing Fixture	Hot Water Usage (gallons per minute)	Number of Fixtures	Hot Water Demand Flow Rate in Gallons Per Minute
Example: Warewashing Machine †Hobart AM14	8.0	1	(8.0 × 1) = 8.0
Example: Handsink(s)	0.5	4	(0.5 × 4) = 2.0
3-Compartment Warewashing Sink*	1.5 for each faucet	2	(1.5 × 2) = 3.0
3-Compartment Bar Sink*	1.5 for each faucet	1	1.5
Utensil Soak Sink	1.0	1	1.0
Warewashing Machine†	8.0	1	8.0
Warewashing Machine Conveyor Pre-rinse†	n/a		
Clothes Washer	2.0	1	2.0
Hand Operated Pre-rinse Sprayer*	1.0	1	1.0
Food Preparation Sink(s)*	0.5	1	0.5
Handwashing Sinks (including restrooms)*	0.4	5	(0.4 × 5) = 2.0
Mop/Utility Sinks	1.0	1	1.0
Garbage Can Washers	1.0	1	1.0
Shower Head*	0.5	2	(0.5 × 2) = 1.0
Hose Bibb used for cleaning	5.0	1	5.0
Total Hot Water Demand Flow Rate (GPM) Required:			***27***

* A flow rate reduction can be used for low flow water faucets installed on 3-compartment sinks, hand operated pre-rinse sprayers, food preparation sinks, handwashing sinks and shower heads by entering the manufacturer's flow rate listed for the faucet or faucet's aerator.

† Use manufacturer's flow rate in GPM for specific make and model of warewashing machine.

Step #2; *Calculate the maximum hot water flow rate for the establishment:*

Note: The planner states within the proposed food service establishment plans that the site of the proposed establishment is at an altitude of 2000 feet above sea level.

Use the following equation to *determine the establishment's maximum flow rate in GPM:*

(0.04 × 2000 ÷ 1000) + 1 = 1.08
Elevation of facility — adjustment factor

1.08 × ***27*** = ***29.16***
Adjustment factor — total hot water demand flow rate calculated in Chart K-5 on page K26 — maximum GPM hot water flow usage

Step #3; *Determine the number of heating units* that will be needed to meet the required maximum hot water flow rate for the establishment:

Heater Specifications from the proposed food service establishment plans:

Manufacturer: X Factor Model Number: X1A001

Flow Rate in Gallons Per Minute (GPM) at 100°F rise: 3.0 GPM
BTU Rating: 15,000 BTUs

29.16 ÷ 3.0 = 9.72 ~ 9.72 or **10 Units**
Maximum GPM hot water Flow usage calculated in Step #2 above — manufacturer's flow rate in GPM @100°F or 80°F rise** — number of heating units required*

*Multiple units must be installed and plumbed to operate in a parallel configuration.
**If there are no high temperature dishwashing machine or other fixtures requiring input water temperatures of 140°F (100°F rise) or more, then 80°F rise can be used.

Step #4; *Storage Tank Sizing:*

Dishwashing Machine*

Manufacturer: Hobart Model Number: AM14
Gallons Per Hour Water Consumption: **52** × 0.25 = **13.0**
Storage tank capacity in gallons
Calculated Storage Tank Capacity: **13.0** vs. 25 Gallon Storage Tank
Enter the larger of the two: **25** Required Storage Tank Capacity

Step # 5; *Booster heater calculation*:

Because the warewashing machine has a fresh rinse, sanitizing final rinse to sanitize food contact surfaces of utensils and equipment placed in it for treatment, an external booster heater would have to be installed. The booster heater would require 140°F water coming into the unit in order for it to boost it to at least the required 180°F sanitizing rinse. In order to properly size the booster heater, you would need to size the unit based on gallons per hour (GPH) to determine the BTUs or KWs input rating of the booster heater. For Example:

Determine GPH:

Warewashing Machine – Hobart AM-14 Final Rinse GPH = 74*
GPH = *74 GPH Final Rinse* (from manufacturer cut sheet) × *70% (or .70)* = 51.8 (or ***52 GPH***)

**Note:* *Figure from Manufacturer's specifications for warewashing machine in gallons per hour.*

Determine BTUs or KWs Capacity Required for Booster Heater to meet the final rinse hot water demand of the warewashing machine:

Equipment	MHHWDTF-GPH Demand from Chart K-1	Temperature Required	Temperature Rise
Hot Water Sanitizing Mechanical Warewashing Machine[20]	52	180ºF	180ºF - 140ºF = 40ºF

$$\frac{52 \text{ (gph)} \times 40^{\circ}\text{F temperature rise} \times 8.33}{.75 \text{ (operating efficiency)}} = 23{,}101.87 \sim \textit{23,102 BTU's}$$

$$\frac{52 \text{ (gph)} \times 40^{\circ}\text{F temperature rise} \times 8.33}{3412 \text{ (BTU's per KW)}} = 5.078 \sim \textit{5.1 KW's}$$

Conclusion:

From the above 4 Steps, it appears that a single, properly installed on-demand water heating unit with a *3.0 GPM flow rate at 100°F rise and a 15,000 BTU rating* ***will not*** be sufficient to meet a total hot water demand flow rate of *27 GPM* for the fixtures and equipment listed within the proposed plans and specifications for "Restaurant X". This means that the tankless or on-demand hot water system will need to be resized to meet the peak hot water demand of the food service establishment. Additionally and because a hot water sanitizing warewashing machine is proposed, a storage take with a capacity of 25 gallons must be include in the installation of the on-demand water heating system. A booster heater rated at 23, 102 BTUs or 5.1 KWs would be required to meet the fresh hot water sanitizing rinse demand of the planned warewashing machine.

[20] A booster heater must be provided and sized to supply the minimum 180ºF at the final fresh hot water rinse manifold. The exception would be if the warewashing machine had a booster heater incorporated in its design – example some under-the-counter warewashers.

Illustration K-2

Manufacturer's Specification Sheets

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A.O. Smith

CONSERVATIONIST

COMMERCIAL GAS
TANK-TYPE WATER HEATERS
BT-65, 80, 100

Lime Tamer

LIME TAMER™ MODELS

FEATURES

Meets ASHRAE 90A-1980 (1982 requirements) and California energy codes.

GLASS-LINED TANK — Assures years of rust-free clean hot water.

FULLY AUTOMATIC CONTROLS WITH SAFETY SHUTOFF — Accurate dependable control system requires no electric connections. Fixed automatic gas shutoff device for added safety.

HEAVY GAUGE STEEL JACKET — Finished with baked enamel over bonderized undercoat.

GLASS FIBER INSULATION — Double density insulation. Saves fuel, helps reduce standby heat loss.

CERTIFICATION — Units are design certified by the American Gas Association (Canadian Gas Association for units built in Canada). Meets rigid requirements of the National Sanitation Foundation for 180° hot water service. Certified for installation on combustible flooring.

EASY TO INSTALL — Completely factory assembled. Only gas, water and vent connections need be made. All connections are located in front and top of heaters for ease of installation and service.

DRAFT DIVERTER — Low profile diverter furnished as standard equipment (BT-80 and 100 only).

MAXIMUM WORKING PRESSURE — 150 psi.

HANDHOLE CLEANOUT — On 75 and 100 gallon models. Allows easy tank cleaning.

OTHER FEATURES

• Built-in gas filter and integral dirt leg (propane only) • Magnesium anode protection • Equipped with gas pressure regulator • Integral automatic gas shutoff system prevents excessive water temperature • Factory installed temperature and pressure relief valve • Consult local codes.

FOR UNITS BUILT IN USA

NSF

LIMITED WARRANTY OUTLINE

If the tank should leak any time during the first three years, under the terms of the warranty, then A. O. Smith will furnish a replacement heater; installation, labor, handling and local delivery extra. This outline is not a warranty. For complete information, consult the written warranty or A. O. Smith Consumer Products Division.

RECOVERY CAPACITIES

Model	Approx. Gal. Cap.	Type of Gas	Input Rating BTU/HR	Temperature Rise - Degrees F - Gallons Per Hour											
				30	40	50	60	70	80	90	100	110	120	130	140
BT-65	50	Nat. & Prop.	50,000	150	113	90	75	64	56	50	45	41	38	35	32
BT-80	75	Nat. & Prop.	75,100	225	169	135	113	96	85	75	68	61	56	52	48
BT-100	100	Nat. & Prop.	80,000	240	180	144	120	103	90	80	72	65	60	55	51

NOTE. To compensate for the effects of high altitude areas above 2000 feet, recovery capacity should be reduced approximately 4% for every 1000 feet above sea level.

Capacity ratings are actual heater performance at 75% thermal efficiency obtained in A. O. Smith engineering laboratories. A.G.A. ratings are based on an assigned thermal efficiency of 70%. A.G.A. ratings may be obtained by multiplying the above figures by 0.93.

Illustration K-3
Examples: Equipment Providing or Utilizing Hot Water

External Electric Booster Heater

Hose Reel

Warewashing Sink
Hot Water Sanitizing
Compartment Heater

Pre-rinse Spray

Meat Band-Saw
(In-Place Cleaning)

Hot Fresh Water Rinse Sanitizing Warewashing Machine with Built-In Booster Heater

Chemical Sanitizing Warewashing Machine

Illustration K-4

Under-the-Sink Water Heating Alternative to Hot Water Recirculation Systems

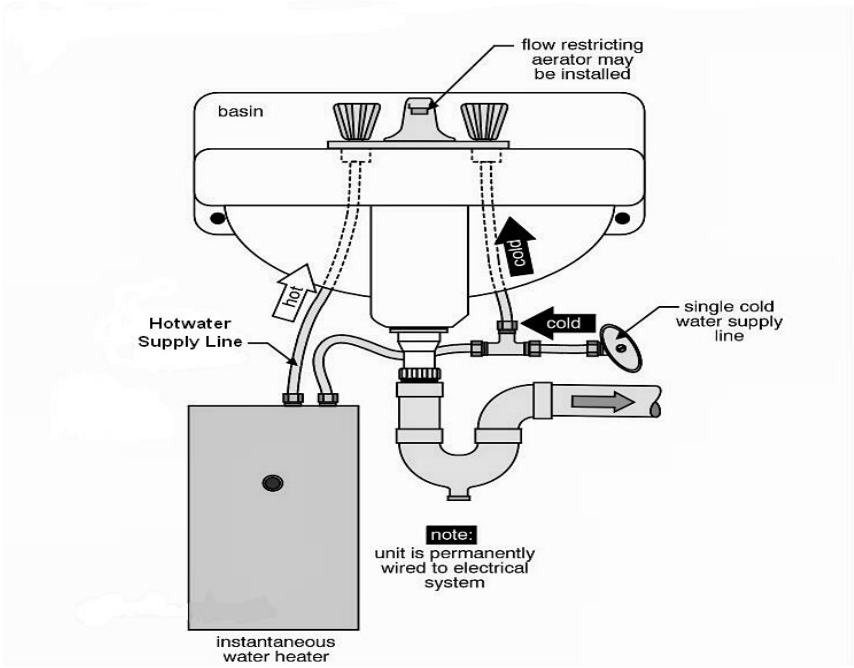


Illustration K-5
On-Demand Water Heating Systems General Operation

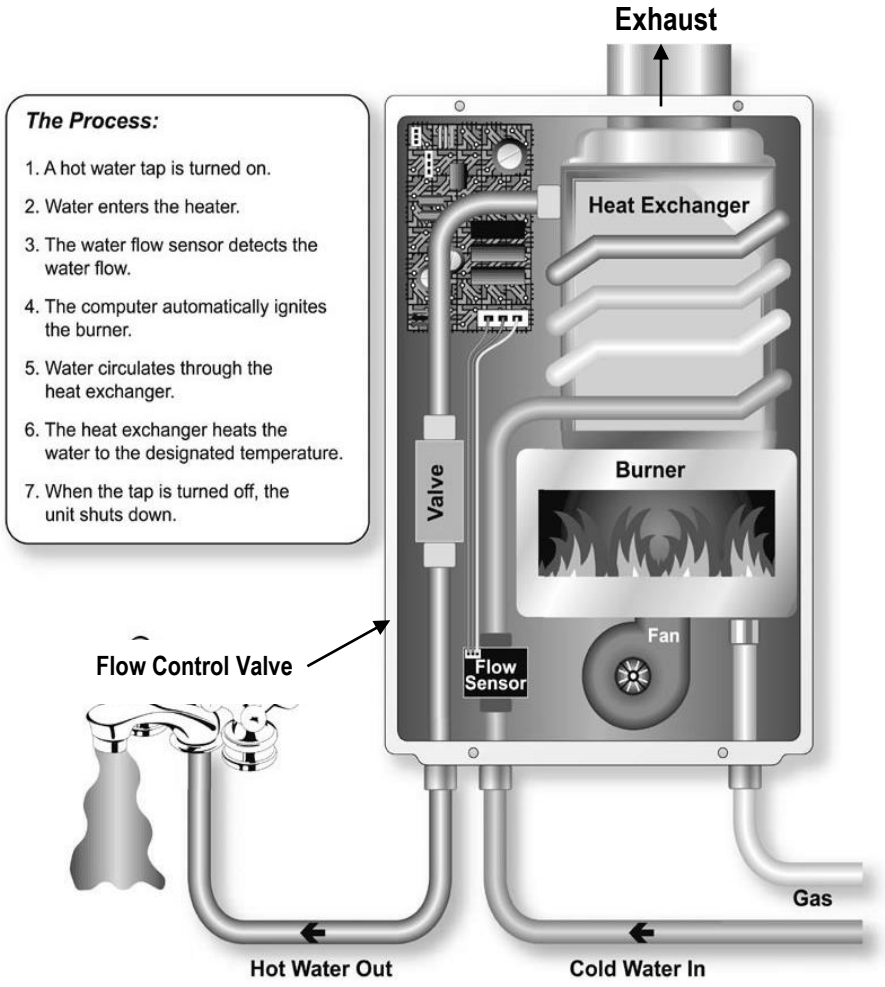


Illustration K-6

Examples of On-Demand Water Heating System Installations

On-Demand Water Heaters in Series

Illustration K-7

On-Demand Water Heating Systems vs. Traditional Storage Tank Type Water Heating Systems

Tankless or
On-Demand Water Heater

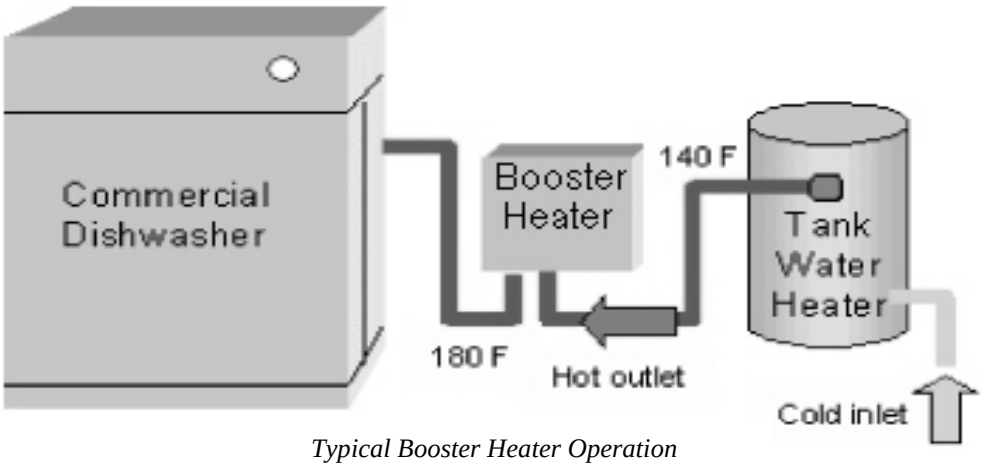
They do not have a storage tank and they generate hot water upon demand created by fixtures or equipment. As a result, they do not use energy when idle (or when there is no demand). If not size correctly to the combined flow rates of all installed fixtures and equipment, they are not capable of keeping up with hot water demand, resulting in a shortage of hot water. As a result, there will not be enough hot water to properly wash hands and to operate equipment, such as warewashing machines. Additionally and if not sized correctly, the flow of water at fixtures can be greatly reduced; thereby, reducing the force needed agitation to clean-off debris from objects, such as cleaning hands during handwashing.

Tank-Type *(or Storage Type)* Water Heater

They slowly heat cold water at the bottom of the tank as stored heated water at the top of the tank is depleted by demand from fixtures and equipment. If sized correctly to all installed fixtures and equipment, it will provide a constant amount of hot water at fixed rate in gallons per hour. They operate by stored water temperature and they burn energy often to maintain a set temperature in the storage tank whether or not hot water is being demanded by fixtures and equipment.

Illustration K-8
Booster Heater General Operation

External Electric Booster Heater



Typical Booster Heater Operation