ASHRAE Modified Hunter Curve - Flow Charts

Chart 12-1

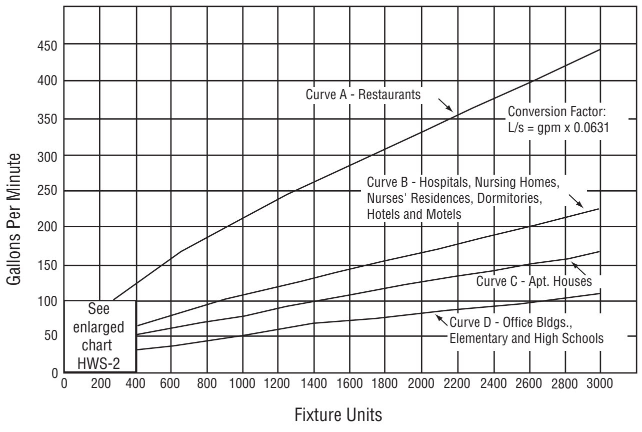
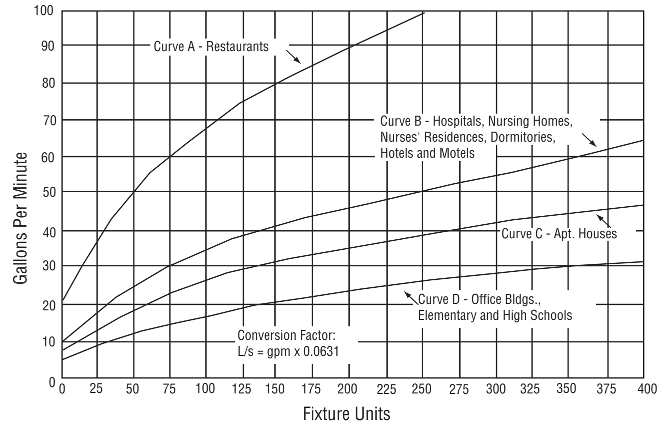


Chart 12-2. Enlarged Section



Hunter curves should be used for intermittent, insignificant fixtures only.

Step 1

Determine the total fixture unit load for all the fixtures serviced by your water heater application using the Fixture Units Table on page 13. See example below.

Step 2

Using the total fixture units for your application, enter the Hunter Curves (Chart 12-1) from the bottom on the total fixture units line for your application. Read up to the curve that best fits the application. Then read to the left for the corresponding gpm requirement.

Step 3

Select the proper Armstrong Water Heater/Water Temperature Controller.

Example: College Dormitory

No. Fixtures	Type of Fixture	Fix. Unit	Demand Fix. Unit
150	Private Lavatory	.75	113
120	Private Shower	1.5	180
20	Slop Basin	2.5	50
8	Clothes Washer	2.0	16
Total Fixture Units			**359**

Refer to the modified Hunter Curves in Chart 12-2. Curve B represents dormitories. Enter the graph from the bottom at 359 fixture units and go up to curve B. Then move to the left horizontally to read approximately 60 gallons per minute of hot water capacity required.

NOTE: Remember to add any constant flow capacities, as determined under "Important Note" below, to this 60 gpm.

Important Note

Special consideration should be given to applications involving periodic use of gang showers, process equipment, laundry machines, etc., as may occur in field houses, gymnasiums, factories, hospitals, etc. Because these applications could have all equipment on at the same time, their total hot water capacity should be determined and then added to the maximum hot water demand as read from the modified Hunter Curves. Use the following formula to determine total hot water capacity needed for these applications when final water temperatures are lower than that of the water heater.

$$\frac{(B - C)}{(H - C)} \times \left(\begin{array}{c}\text{Total water flow from all}\\ \text{gang shower heads in gpm}\end{array}\right) = \text{Hot water needed (gpm)}$$

Where:

B = Blended water temperature out of the fixture
H = Hot water temperature to the fixture
C = Cold water temperature to the fixture

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ASHRAE Modified Hunter Curve - Fixture Units

Armstrong®

140°F Temperature From Heater

Hospital

Type of Fixture	Fix. Units
Private Lavatory	.75
Public Lavatory	1.0
Semi-Private Lavatory	1.2
†Private Shower	1.5
†Ward Shower	2.5
†Semi-Private Shower	1.5
Private Bath	1.5
Ward Bath	2.0
Sink - Flushing Rim	2.0
Sink - Scrub-Up	1.5
Sink - Laboratory	1.5
Sink - General Purpose	1.0
Bath - Leg	6.0
Bath - Arm	4.0
Bath - Sitz	3.0
Bath - Foot	3.0
Bath - Emergency	2.0
Hydrotherapeutic Showers	
#1 Shower Head	8.0
#2 Spray	12.0
Continuous Flow Bath	
Continuous Flow Fill	2.0
Continuous Flow Operate	1.5
Hubbard	4.0
Autopsy Table	2.0
Autopsy Sink and Table	2.5

Club

Type of Fixture	Fix. Units
Private Lavatory	.75
Public Lavatory	1.0
†Private Shower	1.5
†Public Shower	1.7
†Tub and Shower	1.5
Sink - Slop	2.5
36" Half Bradley	1.0
36" Full Bradley	1.5
54" Half Bradley	1.5
50" Full Bradley	2.0

Gymnasium

Type of Fixture	Fix. Units
Private Lavatory	.75
Public Lavatory	1.0
Private Shower	1.5
Public Shower	3.0
Sink - Slop	1.5
Basin - Foot	1.2
36" Half Bradley	1.0
36" Full Bradley	1.5
54" Half Bradley	1.5
54" Full Bradley	2.0

Assoc. Bldg. YMCA

Type of Fixture	Fix. Units
Private Lavatory	.75
Public Lavatory	1.0
†Private Shower	1.5
†Tub and Shower	1.7
Sink - Slop	2.5
Janitor Drop	2.0

Restaurant**

Type of Fixture	Fix. Units
Private Lavatory	.70
Public Lavatory	2.0
†Private Shower	1.5
†Public Shower	1.7
Sink - Kitchen	3.0
Sink - Pantry	2.5
Sink - Slop	2.0
Sink - Pot (Single)	2.5
Sink - Pot (Double)	3.5
Sink - Pot (Triple)	5.5
Sink - Vegetable	2.0
Sink - Bar	2.5
Washer - Silver	2.0*
Washer - Glass	2.0*
Washer - Can	3.0
Coffee Urn	1.2
Bain Marie	1.0
Pot and Pan Washer	2.0*
Dish Pre-Rinse	2.5
Pre-Scraper	2.0
Pre-Scraper Conveyor	2.5
36" Half Bradley	1.0
36" Full Bradley	1.5

*Dishwashers (use booster to heat from 140° to 180°F)

Type of Fixture	Fix. Units
Single Tank - Stationary Rack	
16 x 16 Rack	2.5
18 x 18 Rack	3.9
20 x 20 Rack	4.2
Multiple Tank Conveyor Type	
Dishes - Inclined	2.0
Dishes - Flat	2.5
Single Tank Conveyor Type	2.3

Hotel - Motel

Type of Fixture	Fix. Units
Private Lavatory	.75
Public Lavatory	1.0
†Private Shower	1.5
†Tub and Shower	1.5
Basin - Barber	2.0
Sink - Slop	2.5
Basin - Beauty Parlor	2.5

Office Building

Type of Fixture	Fix. Units
Private Lavatory	.75
Public Lavatory	1.0
Private Shower	1.5
Sink - Slop	2.5
Janitor Drop	2.5
36" Half Bradley	1.0
36" Full Bradley	1.5

Factory

Type of Fixture	Fix. Units
Private Lavatory	.75
Public Lavatory	1.0
†Private Shower	1.5
†Public Shower	3.0
Sink - Slop	2.5
36" Half Bradley	1.0
36" Full Bradley	1.5
54" Half Bradley	1.5
54" Full Bradley	2.0

Correctional or Mental Institution

Type of Fixture	Fix. Units
Private Lavatory	.70
Public Lavatory	1.0
†Private Shower	1.5
†Public Shower	3.0
†Tub and Shower	1.5
Sink - Slop	2.0
Janitor Drop	2.0
36" Half Bradley	1.0
36" Full Bradley	1.5
54" Half Bradley	1.5
54" Full Bradley	2.0

Apartment

Type of Fixture	Fix. Units
Private Lavatory	.75
Public Lavatory	1.0
†Private Shower	1.5
†Public Shower	1.5
†Tub and Shower	1.5
Sink - Kitchen	.75
Sink - Slop	1.5
Sink - Pantry	1.5
Domestic Clothes Washer	1.2
Domestic Dishwasher	1.5
Laundry Tray	1.5

Private - Public School

Type of Fixture	Fix. Units
Private Lavatory	.75
Public Lavatory	1.0
†Private Shower	1.5
†Tub and Shower	1.7
Sink - Slop	2.5
Janitor Drop	1.5
Domestic Clothes Washer	2.0
Domestic Dishwasher	2.0

Institution - Home

Type of Fixture	Fix. Units
Private Lavatory	.70
Public Lavatory	1.0
†Private Shower	1.5
†Tub and Shower	1.5
Sink - Slop	2.0
Janitor Drop	2.0

*These items require 180°F hot water. The consumption figures are based on supplying 140°F water with a booster heater used to obtain 180°F water.

**Add 20% to all figures when not used in combination with other building services from same heater.

†The fixture units listed for shower heads are based on a flow rate of 3 gpm. These units should be corrected for other flow rates. Multiply the fixture units by Correction Factor "C" from the formula: C = G x .33, where C = Correction Factor and G = gpm of shower head being used. Example: Shower head 4 gpm = C = 4 x .33 or 1.32. From Fixture Units Table, Hotel-Motel (shower) which shows 1.5 fixture units, multiply 1.5 x 1.32 = 2.10 fixture units per shower head using 4 gpm.

Hot Water Storage versus Semi-Instantaneous Hot Water Generation

Stand-by heat losses associated with larger storage vessels and the additional energy required to run the inter-tank circulating pumps is neither cost effective nor "green".

With Flo-Eco, large storage vessels are not required and in most installations facility demands for hot water are more effectively met by increased btu input.

Generally, only applications with large demands, over a short period of time, justify the use of large capacity storage vessels.

The High Efficiency Solution

In many cases high efficiency water heaters such as the Flo-Eco can be "sized down" in comparison with or when being compared with a standard efficiency water heater with the same Btu input.

In addition, the ability to "stack" up to three Flo-Eco on a single footprint offers system redundancy below 200,000 Btu/hr per heater module.

The historical tendency to rely upon storage vessels to provide a feeling of "security" that the facility has an ample supply of stored hot water in the event of a significant sudden demand requires some examination.

For example a design might call for a water heater to operate under the following conditions:

Incoming Water Temperature = 40°F
Water Heater Set Point = 120°F
Temperature Rise = 80°F
Demand = 15 GPM

Based on the shaded information above, a typical selection might be 600,000 BTU input and 600 gallons of storage. The thinking being that 600 gallons of 120°F stored water will cover any and all surges in demand and allow the water heater ample time to recover.

In actual fact however the moment there is hot water demand on the water heater the 600 gallons of 120°F water is immediately diluted with cold water as it enters the tank. The higher the flow the greater the turbulence within the tank the faster the temperature falls off.

Under the same installation scenario, Armstrong can replace 600,000 btu's of input and 600 gallons of storage with 600,000 btus of input and 180 gallons of storage and deliver superior hot water generation performance.

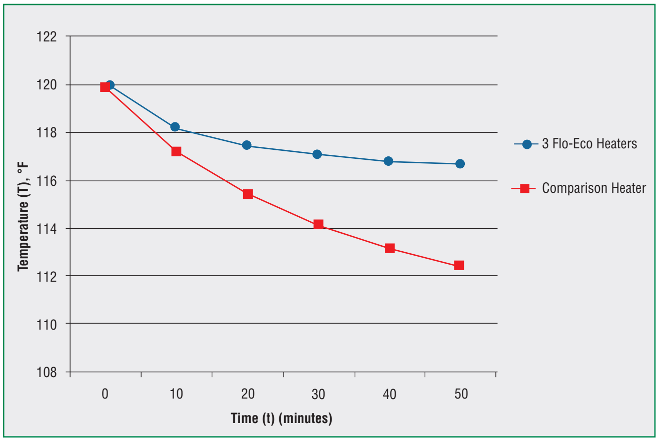
Example:

Standard Efficiency Water Heater

Input = 600,000 Btu/Hr.
Output = 498,000 Btu/Hr.
Efficiency = 83%
Storage Capacity = 600 gallons
Incoming Water Temperature = 40°F.
Heater Set Point = 120°F.
Delivery = 498,000/8.35/120 = 497 GPH @ 80°F rise.

Flo-Eco 95- 3 (Triple) High Efficiency Water Heater

Input = 600,000 Btu/Hr.
Output = 570,000 Btu/Hr.
Efficiency = 95%
Storage Capacity = 180 gallons
Incoming Water Temperature = 40°F.
Heater Set Point = 120°F.
Delivery = 570,000/8.35/120 = 568 GPH @ 80°F rise (+12%).



Commercial and General Application Sizing

Integrating "The Brain" Digital Recirculating Valve (DRV)

Flo-Eco water heaters are designed to generate and store hot water at elevated temperatures.

Digital water temperature control is incredibly dependable. Combined with the high temperature alert and system connectivity features we can confidently specify higher hot water generation temperatures.

As a result, at a typical hot water setpoint of 120°F, an elevated generation and storage temperature enhances the total system capacity.

In addition, higher hot water generation and storage temperatures promote compliance with OSHA, CDC and other national and global Legionella management guidelines.

Example - Water Heater only:

Storage Capacity = 180 gallons
Cold Water Temperature = 40°F
Water Heater Set Point = 120°F
System Set Point =120°F
Hot Water availability at 120°F = 180 gallons

Example - Water Heater with integral Brain:

Storage Capacity = 180 gallons
Cold Water Temperature = 40°F
Water Heater Set Point = 160°F
System Set Point = 120°F
Additional Cold Water added to mix to 120°F = 92 gallons
Hot Water availability at 120°F = **272 gallons**

What about the "on call" hot water in the building pipework?

Factoring in the building's re-circulating plumbing system further enhances the principle that in many cases smaller is better.

Consider that a 2" diameter 12 long piece of copper pipe holds .375 US gallons of water. That means a 1000 linear foot re-circulating hot water system contains 375 gallons of water at or at least close to the desired system temperature.

Total Hot Water Solution

- Btu inputs which deliver satisfactory recovery
- Storage capacity which supports periods of high demand
- Digital mixing valve integration which offers enhanced capacity by adjusting the generation set point
- an understanding of the amount of "on call" domestic hot water the plumbing system has available

. . . are all important components of a total *High Efficiency Hot Water and Digital Control System*.

Flo-Eco Sizing

For simplicity purposes we provide a rudimentary sizing formula below. For more specific application and sizing support please contact Armstrong directly or visit our website at **armstrong**international.com/flo-eco to access sizing formula.

BTU/h Input Requirement

- Apply Modified Hunter Curve to fixture count
- Convert to GPM
- Select Incoming Water Temperature = °F
- Select Desired Outlet Temperature = °F
- Calculate Temperature Rise
- GPM (Temperature Rise) X 500 = BTU
- Apply Armstrong Diversity factor of .72
- Divide BTU/h by 200,000 to determine number of Flo-Eco modules required.

Amount of Stored Hot Water

- Number of modules required multiplied by 60 = Amount of Stored Hot Water

Recovery Rate

Recovery Rate in Gallons Per Hour =
Btu/weight of 1 gallon of water/Temperature Rise

GPH = Btu / 8.35 / ΔT