Dry Storage Chart # 6 - Formula #2

calculated storage area per .045 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	5	6.00	4.50	3.60	3.00
250	5	7.50	5.63	4.50	3.75
300	5	9.00	6.75	5.40	4.50
350	5	10.50	7.88	6.30	5.25
400	5	12.00	9.00	7.20	6.00
450	5	13.50	10.13	8.10	6.75
500	5	15.00	11.25	9.00	7.50
550	5	16.50	12.38	9.90	8.25
600	5	18.00	13.50	10.80	9.00
650	5	19.50	14.63	11.70	9.75
700	5	21.00	15.75	12.60	10.50
750	5	22.50	16.88	13.50	11.25
800	5	24.00	18.00	14.40	12.00
850	5	25.50	19.13	15.30	12.75
900	5	27.00	20.25	16.20	13.50
950	5	28.50	21.38	17.10	14.25
1000	5	30.00	22.50	18.00	15.00

calculated storage area per .05 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	5	6.67	5.00	4.00	3.33
250	5	8.33	6.25	5.00	4.17
300	5	10.00	7.50	6.00	5.00
350	5	11.67	8.75	7.00	5.83
400	5	13.33	10.00	8.00	6.67
450	5	15.00	11.25	9.00	7.50
500	5	16.67	12.50	10.00	8.33
550	5	18.33	13.75	11.00	9.17
600	5	20.00	15.00	12.00	10.00
650	5	21.67	16.25	13.00	10.83
700	5	23.33	17.50	14.00	11.67
750	5	25.00	18.75	15.00	12.50
800	5	26.67	20.00	16.00	13.33
850	5	28.33	21.25	17.00	14.17
900	5	30.00	22.50	18.00	15.00
950	5	31.67	23.75	19.00	15.83
1000	5	33.33	25.00	20.00	16.67

Dry Storage Chart # 7 - Formula #2

calculated storage area per .025 cu. ft. per meal served						calculated storage area per .03 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	6	2.78	2.08	1.67	1.39	200	6	3.33	2.50	2.00	1.67
250	6	3.47	2.60	2.08	1.74	250	6	4.17	3.13	2.50	2.08
300	6	4.17	3.13	2.50	2.08	300	6	5.00	3.75	3.00	2.50
350	6	4.86	3.65	2.92	2.43	350	6	5.83	4.38	3.50	2.92
400	6	5.56	4.17	3.33	2.78	400	6	6.67	5.00	4.00	3.33
450	6	6.25	4.69	3.75	3.13	450	6	7.50	5.63	4.50	3.75
500	6	6.94	5.21	4.17	3.47	500	6	8.33	6.25	5.00	4.17
550	6	7.64	5.73	4.58	3.82	550	6	9.17	6.88	5.50	4.58
600	6	8.33	6.25	5.00	4.17	600	6	10.00	7.50	6.00	5.00
650	6	9.03	6.77	5.42	4.51	650	6	10.83	8.13	6.50	5.42
700	6	9.72	7.29	5.83	4.86	700	6	11.67	8.75	7.00	5.83
750	6	10.42	7.81	6.25	5.21	750	6	12.50	9.38	7.50	6.25
800	6	11.11	8.33	6.67	5.56	800	6	13.33	10.00	8.00	6.67
850	6	11.81	8.85	7.08	5.90	850	6	14.17	10.63	8.50	7.08
900	6	12.50	9.38	7.50	6.25	900	6	15.00	11.25	9.00	7.50
950	6	13.19	9.90	7.92	6.60	950	6	15.83	11.88	9.50	7.92
1000	6	13.89	10.42	8.33	6.94	1000	6	16.67	12.50	10.00	8.33

Dry Storage Chart # 8 - Formula #2

calculated storage area per .035 cu. ft. per meal served						calculated storage area per .04 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	6	3.89	2.92	2.33	1.94	200	6	4.44	3.33	2.67	2.22
250	6	4.86	3.65	2.92	2.43	250	6	5.56	4.17	3.33	2.78
300	6	5.83	4.38	3.50	2.92	300	6	6.67	5.00	4.00	3.33
350	6	6.81	5.10	4.08	3.40	350	6	7.78	5.83	4.67	3.89
400	6	7.78	5.83	4.67	3.89	400	6	8.89	6.67	5.33	4.44
450	6	8.75	6.56	5.25	4.38	450	6	10.00	7.50	6.00	5.00
500	6	9.72	7.29	5.83	4.86	500	6	11.11	8.33	6.67	5.56
550	6	10.69	8.02	6.42	5.35	550	6	12.22	9.17	7.33	6.11
600	6	11.67	8.75	7.00	5.83	600	6	13.33	10.00	8.00	6.67
650	6	12.64	9.48	7.58	6.32	650	6	14.44	10.83	8.67	7.22
700	6	13.61	10.21	8.17	6.81	700	6	15.56	11.67	9.33	7.78
750	6	14.58	10.94	8.75	7.29	750	6	16.67	12.50	10.00	8.33
800	6	15.56	11.67	9.33	7.78	800	6	17.78	13.33	10.67	8.89
850	6	16.53	12.40	9.92	8.26	850	6	18.89	14.17	11.33	9.44
900	6	17.50	13.13	10.50	8.75	900	6	20.00	15.00	12.00	10.00
950	6	18.47	13.85	11.08	9.24	950	6	21.11	15.83	12.67	10.56
1000	6	19.44	14.58	11.67	9.72	1000	6	22.22	16.67	13.33	11.11

Dry Storage Chart # 9 - Formula #2

calculated storage area per .045 cu. ft. per meal served						calculated storage area per .05 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	6	5.00	3.75	3.00	2.50	200	6	5.56	4.17	3.33	2.78
250	6	6.25	4.69	3.75	3.13	250	6	6.94	5.21	4.17	3.47
300	6	7.50	5.63	4.50	3.75	300	6	8.33	6.25	5.00	4.17
350	6	8.75	6.56	5.25	4.38	350	6	9.72	7.29	5.83	4.86
400	6	10.00	7.50	6.00	5.00	400	6	11.11	8.33	6.67	5.56
450	6	11.25	8.44	6.75	5.63	450	6	12.50	9.38	7.50	6.25
500	6	12.50	9.38	7.50	6.25	500	6	13.89	10.42	8.33	6.94
550	6	13.75	10.31	8.25	6.88	550	6	15.28	11.46	9.17	7.64
600	6	15.00	11.25	9.00	7.50	600	6	16.67	12.50	10.00	8.33
650	6	16.25	12.19	9.75	8.13	650	6	18.06	13.54	10.83	9.03
700	6	17.50	13.13	10.50	8.75	700	6	19.44	14.58	11.67	9.72
750	6	18.75	14.06	11.25	9.38	750	6	20.83	15.63	12.50	10.42
800	6	20.00	15.00	12.00	10.00	800	6	22.22	16.67	13.33	11.11
850	6	21.25	15.94	12.75	10.63	850	6	23.61	17.71	14.17	11.81
900	6	22.50	16.88	13.50	11.25	900	6	25.00	18.75	15.00	12.50
950	6	23.75	17.81	14.25	11.88	950	6	26.39	19.79	15.83	13.19
1000	6	25.00	18.75	15.00	12.50	1000	6	27.78	20.83	16.67	13.89

Dry Storage Chart # 10 - Formula #2

calculated storage area per .025 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	7	2.38	1.79	1.43	1.19
250	7	2.98	2.23	1.79	1.49
300	7	3.57	2.68	2.14	1.79
350	7	4.17	3.13	2.50	2.08
400	7	4.76	3.57	2.86	2.38
450	7	5.36	4.02	3.21	2.68
500	7	5.95	4.46	3.57	2.98
550	7	6.55	4.91	3.93	3.27
600	7	7.14	5.36	4.29	3.57
650	7	7.74	5.80	4.64	3.87
700	7	8.33	6.25	5.00	4.17
750	7	8.93	6.70	5.36	4.46
800	7	9.52	7.14	5.71	4.76
850	7	10.12	7.59	6.07	5.06
900	7	10.71	8.04	6.43	5.36
950	7	11.31	8.48	6.79	5.65
1000	7	11.90	8.93	7.14	5.95

calculated storage area per .03 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	7	2.86	2.14	1.71	1.43
250	7	3.57	2.68	2.14	1.79
300	7	4.29	3.21	2.57	2.14
350	7	5.00	3.75	3.00	2.50
400	7	5.71	4.29	3.43	2.86
450	7	6.43	4.82	3.86	3.21
500	7	7.14	5.36	4.29	3.57
550	7	7.86	5.89	4.71	3.93
600	7	8.57	6.43	5.14	4.29
650	7	9.29	6.96	5.57	4.64
700	7	10.00	7.50	6.00	5.00
750	7	10.71	8.04	6.43	5.36
800	7	11.43	8.57	6.86	5.71
850	7	12.14	9.11	7.29	6.07
900	7	12.86	9.64	7.71	6.43
950	7	13.57	10.18	8.14	6.79
1000	7	14.29	10.71	8.57	7.14

Dry Storage Chart # 11 - Formula #2

calculated storage area per .035 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	7	3.33	2.50	2.00	1.67
250	7	4.17	3.13	2.50	2.08
300	7	5.00	3.75	3.00	2.50
350	7	5.83	4.38	3.50	2.92
400	7	6.67	5.00	4.00	3.33
450	7	7.50	5.63	4.50	3.75
500	7	8.33	6.25	5.00	4.17
550	7	9.17	6.88	5.50	4.58
600	7	10.00	7.50	6.00	5.00
650	7	10.83	8.13	6.50	5.42
700	7	11.67	8.75	7.00	5.83
750	7	12.50	9.38	7.50	6.25
800	7	13.33	10.00	8.00	6.67
850	7	14.17	10.63	8.50	7.08
900	7	15.00	11.25	9.00	7.50
950	7	15.83	11.88	9.50	7.92
1000	7	16.67	12.50	10.00	8.33

calculated storage area per .04 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	7	3.81	2.86	2.29	1.90
250	7	4.76	3.57	2.86	2.38
300	7	5.71	4.29	3.43	2.86
350	7	6.67	5.00	4.00	3.33
400	7	7.62	5.71	4.57	3.81
450	7	8.57	6.43	5.14	4.29
500	7	9.52	7.14	5.71	4.76
550	7	10.48	7.86	6.29	5.24
600	7	11.43	8.57	6.86	5.71
650	7	12.38	9.29	7.43	6.19
700	7	13.33	10.00	8.00	6.67
750	7	14.29	10.71	8.57	7.14
800	7	15.24	11.43	9.14	7.62
850	7	16.19	12.14	9.71	8.10
900	7	17.14	12.86	10.29	8.57
950	7	18.10	13.57	10.86	9.05
1000	7	19.05	14.29	11.43	9.52

Dry Storage Chart # 12 - Formula #2

calculated storage area per .045 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	7	4.29	3.21	2.57	2.14
250	7	5.36	4.02	3.21	2.68
300	7	6.43	4.82	3.86	3.21
350	7	7.50	5.63	4.50	3.75
400	7	8.57	6.43	5.14	4.29
450	7	9.64	7.23	5.79	4.82
500	7	10.71	8.04	6.43	5.36
550	7	11.79	8.84	7.07	5.89
600	7	12.86	9.64	7.71	6.43
650	7	13.93	10.45	8.36	6.96
700	7	15.00	11.25	9.00	7.50
750	7	16.07	12.05	9.64	8.04
800	7	17.14	12.86	10.29	8.57
850	7	18.21	13.66	10.93	9.11
900	7	19.29	14.46	11.57	9.64
950	7	20.36	15.27	12.21	10.18
1000	7	21.43	16.07	12.86	10.71

calculated storage area per .05 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	7	4.76	3.57	2.86	2.38
250	7	5.95	4.46	3.57	2.98
300	7	7.14	5.36	4.29	3.57
350	7	8.33	6.25	5.00	4.17
400	7	9.52	7.14	5.71	4.76
450	7	10.71	8.04	6.43	5.36
500	7	11.90	8.93	7.14	5.95
550	7	13.10	9.82	7.86	6.55
600	7	14.29	10.71	8.57	7.14
650	7	15.48	11.61	9.29	7.74
700	7	16.67	12.50	10.00	8.33
750	7	17.86	13.39	10.71	8.93
800	7	19.05	14.29	11.43	9.52
850	7	20.24	15.18	12.14	10.12
900	7	21.43	16.07	12.86	10.71
950	7	22.62	16.96	13.57	11.31
1000	7	23.81	17.86	14.29	11.90

PART 8 - WAREWASHING FACILITIES

MANUAL WAREWASHING

For manual washing and sanitizing of utensils, provide a stainless steel sink with no fewer than 3 compartments. The sink compartments shall be large enough to hold the largest pot, pan or piece of equipment. Each compartment shall be supplied with adequate hot and cold potable running water. Integral drainboards of adequate size shall be provided on both sides of the sink for cleaned and soiled utensils. When approved, 2 compartment sinks may be allowable under certain conditions. See figure #8-1.

Pitch the drainboards and dish tables a minimum of 1/8" per foot and direct the drainage into the sink. Drainboards should generally be at least the same size as that of the sink compartments. Recommended size is 36-48" long and 30" wide.

Locate a floor drain in the immediate vicinity of the sink in areas where wet pots, utensils and equipment are air-drying. Approved racks, shelves or dish tables are to be provided adjacent to the warewash sink.

Provide adequate facilities for preflushing or prescrapping equipment and utensils.

An approved chemical test kit for determining sanitizer strength shall be available and used.

Working supplies of cleaners and sanitizers must be stored in an approved location. A recommended storage location is on a wire shelf below the drainboard of the 3 compartment sink.

MECHANICAL WAREWASHING

The waste line for all mechanical warewashing machines must not be directly connected to the sewer line. Except that the waste line may be connected directly on the inlet side of a properly vented floor drain when the floor drain is within 5' of the warewashing machine and the drain line from the machine is properly trapped and vented. See figure #8-2.

Adequate facilities shall be provided to air dry washed utensils and equipment. Storage facilities shall be provided to store cleaned and sanitized utensils and equipment at least 12" above the floor on fixed shelves or in enclosed cabinets protected from splash, dust, overhead plumbing or other contamination.

DETERMINING WAREWASH MACHINE CAPACITY

The capacity of the dishwashing machines should be based on the peak number and type of dishes, utensils, flatware, etc. that must be washed per hour. One way to find the capacity in racks per hour for each make and model of machine is to refer to the manufacturer's specification sheets. To determine the required capacity refer to the following guide:

Each 20" x 20" dishrack will accommodate:

16 - 9" dinner plates
25 - water glasses
16 - coffee cups
100 - pieces of flatware

Only 70% of the listed capacity (in racks per hour) should be considered as an average capacity. Consult the manufacturers' specification sheets ("cut sheets") for optimum capacity.

A suggested formula to determine the number of dishracks required per hour for a restaurant serving 200 meals at lunch is as follows:

200 plates = $\frac{\text{200 plates}}{\text{16 plates/rack}}$ = 13 racks

200 water glasses = $\frac{\text{200 glasses}}{\text{25 glasses/rack}}$ = 8 racks

200 coffee cups = $\frac{\text{200 coffee cups}}{\text{16 cups/rack}}$ = 13 racks

200 pieces of flatware = $\frac{\text{200 pieces}}{\text{100 pieces/rack}}$ = 2 racks

Required total working capacity = 36 racks/hour

Since this figure is 70% of the listed capacity, a mechanical dishwasher with a minimum listed capacity of:

$$\frac{36}{.70\ (70\%)} = 51 \text{ racks/hour would be recommended}$$

An adequate facility for preflushing or prescrapping shall be provided on the soiled dish side of the dishwashing machine.

Drainboards shall be provided, be of adequate size for the proper handling of utensils, and located so as not to interfere with the proper use of the warewashing facilities. Mobile dish tables may be acceptable for use in lieu of drainboards.

CHEMICAL WAREWASHING

Chemical warewashing machines shall meet nationally recognized standards and be certified or classified by an ANSI accredited certification program. The installation must conform to applicable code requirements. Among the specific requirements for the installation of an approved chemical warewashing machine are the following:

1. The chemical sanitizing feeder must meet nationally recognized standards and be certified or classified by an ANSI accredited certification program and be compatible with the specific make and model of machine in question.

2. An approved chemical test kit for determining sanitizer strength shall be available and used.

3. A visual flow indicator must be provided to monitor the operation of the sanitizing agent feeder. Other indication devices such as audible alarms may also be used. The flow indication devices must be installed so as to be conspicuous to the operator.

Adequate facilities shall be provided to air dry washed utensils and equipment. Storage facilities shall be provided to store cleaned and sanitized utensils and equipment at least 12" above the floor, protected from splash, dust, overhead plumbing or other contamination; on fixed shelves; or in enclosed cabinets. The plan must specify location and facilities used for storing all utensils and equipment.

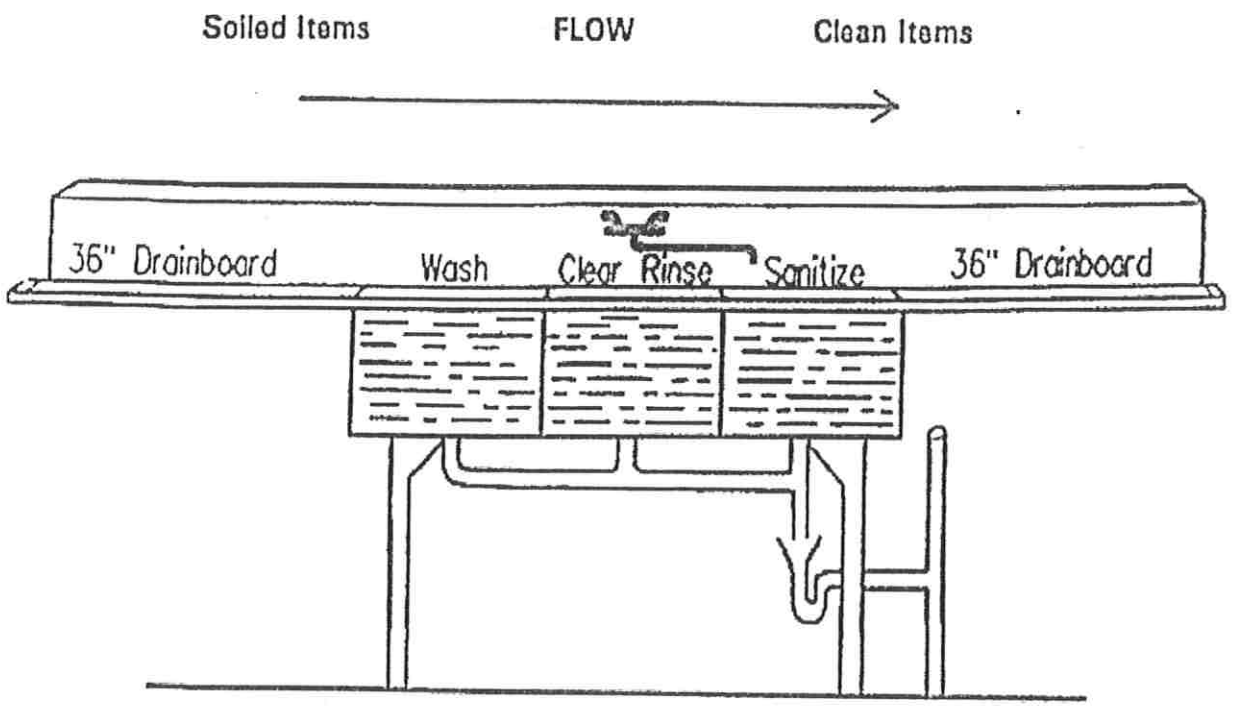
WAREWASHING UTILIZING HOT WATER SANITIZATION

A commercial warewashing machine for mechanical warewashing utilizing hot water for sanitization shall be provided that is in compliance with the standards of an ANSI accredited certification program. The installation and required accessories shall be in conformance with local applicable plumbing codes.

An approved maximum registering thermometer or high temperature test papers shall be available and used.

If the detergent dispenser or drying agent dispenser is not equipped with an integral backflow prevention device, the installation point of the dispenser shall be below the vacuum breaker on the warewashing machine. See figure #8-3.

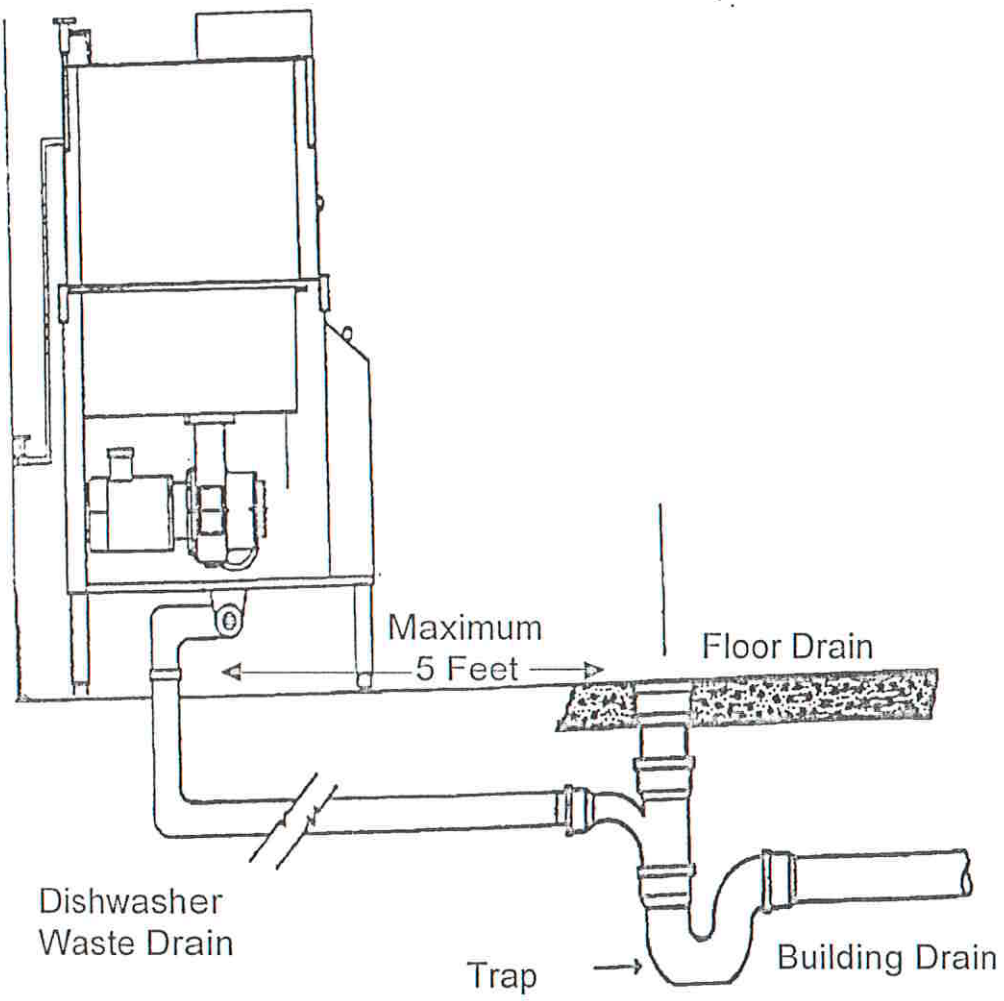
Other references are available for additional formulas and information. One such reference includes: Salvato Textbook. Environmental Engineering & Sanitation 4th Edition. Copyright John Wiley & Sons, Inc. United States. 1992.



Recommended warewashing arrangement using three-compartment sink. Drainboards for soiled dishes and for cleaned utensils must be adequate. A 36" drainboard should have a pitch of ⅛" to ⅜" per foot toward the sink.

Three Compartment Sink With Indirect Waste

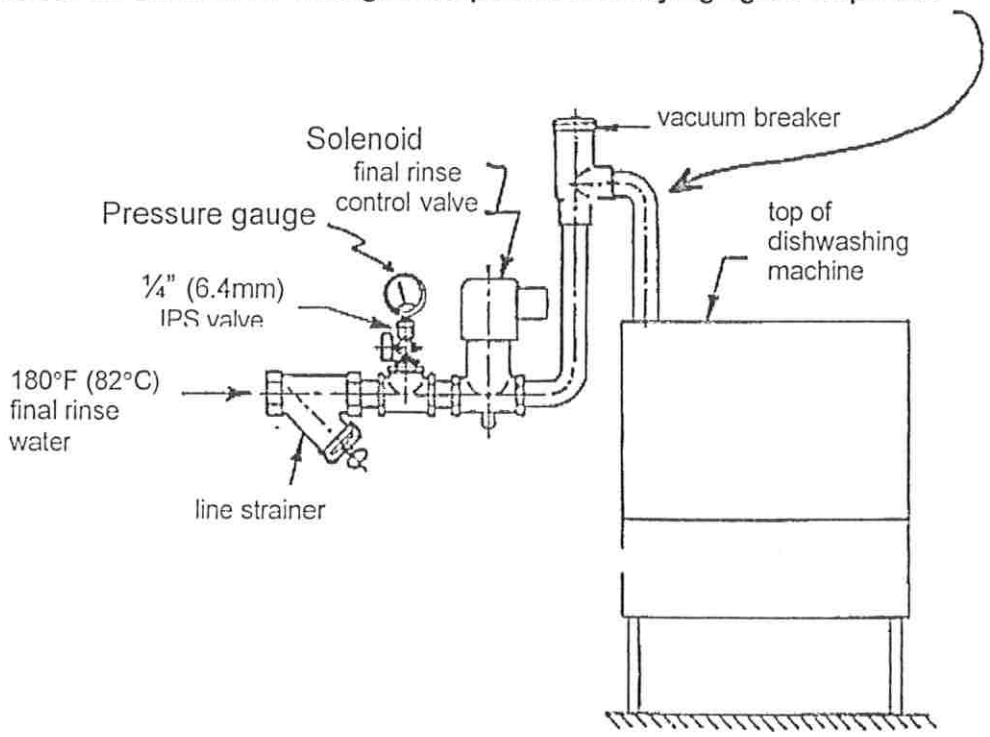
Figure 8-1



Warewashing Machine With a Direct Waste Connection

Figure 8-2

Point of installation for detergent dispenser and drying agent dispenser



Recommended Warewashing Machine Installation

Figure 8-3

PART 9 - DETERMINING HOT WATER SUPPLY REQUIREMENTS

The hot water supply shall be sufficient to satisfy the continuous and peak hot water demands of the establishment. Hot water for handwashing shall be of a temperature of at least 100°F. Hot water for mechanical dishwashing must be 150°F-165°F for washing and 165°F-180°F for sanitizing. The temperature of the wash solution in spray-type warewashers that use chemicals to sanitize may not be less than 110°F. The water temperature for manual hot water sanitization must be at least 171°F. For purposes of sizing the hot water generating capability, assume a supply temperature requirement of 140°F to each fixture and to the mechanical dishwashing machines.

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

Equipment Type	Gallons Per Hour	
	High	Low
Vegetable sink	15	15
Single pot sink	20	15
Double pot sink	40	30
Triple pot sink	60	45
Pre-rinse for dishes-shower head type	45	45
Bar sink-three compartment	20	
Bar sink-four compartment	25	
Chemical sanitizing glasswasher	60	
Lavatory	5	5
Cook sink	10	10
Hot water filling faucet	15	15
Bain Marie	10	10
Coffee urn	5	5
Kettle stand	5	5
Garbage can washer	50	50
Nine and twelve pound clothes washer	45	45
Sixteen pound clothes washer	60	60
Employee shower	20	20

High - To be used when multi-use eating utensils are utilized
Low - To be used in carry-out food operations where single service eating utensils are utilized.

One way to estimate the projected hot water demand (gallons per hour final rinse) of mechanical warewashing machines, pot and pan washers and silverware washers, is to refer to the manufacturers' specification 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 gallons per hour (gph) and temperature rise required (assume an incoming water temperature of 40°F to the food establishment unless specific data are available) for each piece of equipment. These figures can then be converted to BTU's (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.

Note: To calculate BTU's or KW's, use the following formulas: (1 gallon of water = 8.33lbs)

For gas heaters (in BTU's):

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

For electrical heaters (in KW):

$$\text{Required KW} = \frac{\text{Gallons per hour of water} \times \text{Temp. rise} \times 8.33}{3412 \text{ (BTU's per KW)}}$$

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

Equipment	Gallons Per Hour Demand from Chart	Temperature Required	Temp. Rise
3 Comp't sink	60	140°F	100°F

$$\frac{60 \text{ (gph)} \times 100 \text{ degree temp. rise} \times 8.33}{.70 \text{ (operating efficiency)}} = 71{,}400 \text{ BTU's}$$

OR

$$\frac{60 \text{ (gph)} \times 100 \text{ degree temp rise} \times 8.33}{3412 \text{ (BTU's per KW)}} = 14.65 \text{ KW}$$

Assume an incoming water temperature of 40°F into the food establishment.

Equipment	Gallons Per Hour Demand from Chart	Temperature Required	Temp. Rise
Hand sink	5	110°F	70°F

$$\frac{5 \text{ (gph)} \times 70 \text{ degree temp rise} \times 8.33}{.70 \text{ (operating efficiency)}} = 4{,}165 \text{ BTU's}$$

OR

$$\frac{5 \text{ (gph)} \times 70 \text{ degree temp rise} \times 8.33}{3412 \text{ (BTU per KW)}} = 0.85 \text{ KW}$$

This example assumes an incoming water temperature of 40°F into the food establishment.

Equipment	Gallons Per Hour Demand from Chart	Temperature Required	Temp Rise
Chemical/ Mechanical warewasher	64	140°F	100°F

$$\frac{64 \text{ (gph)} \times 100 \text{ degree temp rise} \times 8.33}{.70 \text{ (operating efficiency)}} = 76{,}160 \text{ BTU's}$$

OR

$$\frac{64 \text{ (gph)} \times 100 \text{ degree temp rise} \times 8.33}{3412 \text{ (BTU per KW)}} = 15.62 \text{ KW}$$

This example assumes an incoming water temperature of 40°F into the food establishment and a hot water heater delivery of 140°F hot water to the unit.

Equipment	Gallons Per Hour Demand from Chart	Temperature Required	Temp Rise
Hot water Sanitizing Mechanical warewasher	64	180°F	40°F

$$\frac{64 \text{ (gph)} \times 40 \text{ degree temp rise} \times 8.33}{.70 \text{ (operating efficiency)}} = 30{,}464 \text{ BTU's}$$

$$\frac{64 \text{ (gph)} \times 40 \text{ degree temp rise} \times 8.33}{3412 \text{ (BTU per KW)}} = 6.2 \text{ KW}$$

For mechanical warewashing, 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 rinse temperature.

For the above example, the total demand in BTU's or KW for the primary hot water heater would be:

3 Compartment sink	=	71,400 BTU or 14.65 KW
1 Hand sink	=	4,165 BTU or 0.85 KW
1 Mechanical warewasher	=	76,160 BTU or 15.62 KW
TOTAL DEMAND	=	151,725 BTU or 31.12 KW

A booster heater for the warewasher must be provided and sized to supply an additional 30,464 BTU or 6.2 KW.

All hot water generating equipment should conform to nationally recognized standards and be certified or classified by an ANSI certification program. The manufacturers' specification sheets (cut sheets) should be consulted for hot water supply requirements

The above provides one method of approximation. Other suitably developed calculations may be submitted for consideration. See the Guidelines from the California Directors of Environmental Health as an example of other suitable calculations, also attached are other example calculations from North Carolina's Department of Environmental Health, Food, Lodging, and Institutional Sanitation Branch.

GUIDELINES FOR SIZING WATER HEATERS

California Conference of Directors of Environmental Health
September, 1995

I. BACKGROUND

A critical factor in preventing foodborne illnesses in a food facility is the provision of an adequate supply of hot water for the washing of hands, utensils, equipment, and the facility itself. The installation of a properly sized water heater will ensure that a sufficient amount of hot water will be available at all times.

II. PURPOSE

The purpose of these guidelines is to provide a set of criteria that will assist architects, designers, contractors and owners in properly sizing water heaters to adequately meet the anticipated hot water demands of food facilities in California.

Food facilities with water heaters sized according to these criteria should be capable of complying with the requirements for providing an adequate hot water supply as required by the California Uniform Retail Food Facilities Law.

III. LEGAL AUTHORITY

California Health and Safety Code, Chapter 4, Article 8, Sections 27623, 27624, 27625, 27627, and 27627.3.

IV. DEFINITIONS

- **Booster Heater:** An instantaneous 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 on a high temperature automatic dishmachine.
- **BTU (British Thermal Unit):** The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.
- **GPH (Gallons Per Hour) :** The amount of water, in gallons, that is used each hour by the plumbing fixtures and equipment, such as dishmachines.
- **GPM (Gallons Per Minute) :** The amount of water, in gallons, flowing through a plumbing fixture or through an instantaneous water heater per minute.
- **Instantaneous Water Heater:** A water heater that generates hot water on demand.
- **KW (Kilowatt):** A unit of electric power equal to 1,000 watts.
- **Rise:** The temperature of water as it leaves the water heater minus the temperature of the water entering the water heater.
- **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.
- **Thermal 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.

V. GENERAL REQUIREMENTS

A. A water heater shall be provided which is **capable** of generating an adequate supply of hot water, at a temperature of at least 120° Fahrenheit, to all sinks, janitorial facilities, and other equipment and fixtures that use hot water, at all times.

B. Water heaters and their installation must be in compliance with all local building code requirements.

C. Water heaters that use reclaimed heat from equipment to heat water must be evaluated on a case by case basis.

VI. SIZING REQUIREMENTS FOR STORAGE WATER HEATERS

A. For food facilities that utilize multiservice eating and drinking utensils, the water heater shall have a recovery rate equal to or greater than 100% of the computed hourly hot water demand, in gallons per hour (GPH).

B. For food facilities that use only single-service eating and drinking utensils, or don't use utensils at all, the water heater shall have a recovery rate equal to or greater than 80% of the computed hourly hot water demand, in GPH.

C. For food facilities that handle and sell **only** prepackaged foods, a water heater with a minimum storage capacity of ten gallons must be provided.

D. The hourly hot water demand for the food facility, in GPH, is calculated by adding together the estimated hot water demands for all sinks and other equipment, such as dishmachines, which utilize hot water. The estimated hot water demands for sinks and other equipment that utilize hot water are listed in Appendix I. The hot water demands for automatic warewashers, such as dishmachines, glasswashers, and potwashers are found in NSF International listings or listings established by other nationally recognized testing laboratories.

E. The following examples are provided to explain how to calculate the total hourly hot water demand:

1. Food facility that utilizes only single service eating and drinking utensils:

   Assume:

1 18" X 18" three compartment sink	42 GPH
2 hand lavatories	10 GPH (5 GPH each)
1 janitorial sink	15 GPH
	67 GPH total hourly hot water demand

   67 GPH X 80% allowance for single service utensils = 54 GPH
   For the food facility in this example, a water heater would be required which will recover 54 GPH.

2. Food facility that utilizes multiservice eating and drinking utensils:

   Assume:

1 18" X 18" three compartment sink	42 GPH
automatic dishmachine	80 GPH
hand spray pre-rinse	45 GPH
one compartment food preparation sink	5 GPH

2	hand lavatories	10 GPH (5 GPH each)
1	janitorial sink	15 GPH
		197 GPH total hourly hot water demand

Since the food facility in this example uses multiservice eating and drinking utensils, 100% of the computed hourly hot water demand must be provided. Therefore, a water heater would be required which will recover 197 GPH.

F. To compute a BTU or KW rating for the required hourly hot water demand found in example #1 the following formulas should be used:

Formula 1 (for gas water heaters)

$$\text{BTU input} = \frac{\text{GPH} \times \text{°Rise}^1 \times 8.33 \text{ lb./ gallon of water}}{\text{Thermal Efficiency}^2}$$

$$\text{BTU input} = \frac{54 \text{ GPH} \times 50°\text{F} \times 8.33 \text{ lb.}}{.75}$$

$$\text{BTU input} = 29{,}988$$

[1] The average temperature of tap water varies throughout the state depending upon the location, elevation, and time of year. In order to properly size the water heater check with your local health agency to determine the required rise. For the purposes of these guidelines a tap water temperature of 70° Fahrenheit will be used. Therefore, to achieve a temperature of 120° Fahrenheit at the faucet, the required rise would be 50°.

[2] The thermal efficiency for gas water heaters, unless otherwise listed by NSF International or other nationally recognized testing laboratories, will be assumed to be 75%.

Formula 2 (for electric water heaters)

$$\text{KW input} = \frac{\text{GPH} \times \text{°Rise} \times 8.33 \text{ lb./ gallon of water}}{\text{Thermal Efficiency}^1 \times 3412 \text{ BTU/KW}}$$

$$\text{KW input} = \frac{54 \text{ GPH} \times 50°\text{F} \times 8.33 \text{ lb.}}{.98 \times 3412 \text{ BTU/KW}}$$

$$\text{KW input} = 6.7$$

[1] The thermal efficiency for electric water heaters, unless otherwise listed by NSF International or other nationally recognized testing laboratories, will be assumed to be 98%.

Sizing tables for gas and electric water heaters are found in Appendices II and III respectively.

VII. SIZING REQUIREMENTS FOR INSTANTANEOUS WATER HEATERS

A. One of the advantages of an instantaneous water heater is its ability to provide a continuous supply of hot water. However, since the water passes through a heat exchanger, the water must flow through the unit slowly to assure proper heat transfer. Therefore, 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 facility at the same time the flow of hot water to each fixture can be severely restricted. As a result of the restricted output of instantaneous water heaters, more than one unit may be required, depending on the numbers and types of sinks and equipment present. Due to the limitations inherent in the design of instantaneous water heaters, some local health agencies may restrict or prohibit their usage. Check with your local health agency prior to installing an instantaneous water heater in order to

determine their requirements.

B. Instantaneous water heaters must be sized to provide hot water of at least 120° Fahrenheit, and at a rate of at least two gallons per minute (GPM), to each sink and fixture that utilizes hot water. (Note: Hand lavatories must receive at least 1/2 GPM.) The following example is provided to explain how this sizing criteria is applied:

Assume:

1 18" X 18" three compartment sink	2 GPM
2 hand lavatories	1 GPM (1/2 GPM each)
1 janitorial sink	2 GPM
	5 GPM

C. In the example given above, one or more instantaneous water heaters would have to be provided in order to supply a total of at least 5 GPM.

D. Food facilities that install an automatic warewashing machine that utilizes a large quantity of hot water may be required to provide an instantaneous water heater exclusively for the warewashing machine. NSF International listings or listings established by other nationally recognized testing laboratories are used to determine the minimum GPM hot water demand for automatic warewashing machines.

VIII. REQUIREMENTS FOR BOOSTER HEATERS

A. When a hot water sanitizing warewashing machine is used, a booster heater must be provided that will raise the incoming general purpose hot water up to at least 180° Fahrenheit for the final sanitizing rinse cycle.

B. When sizing a booster heater, the hot water demand for the warewashing final sanitizing rinse cycle should be obtained from the NSF International listings or listings established by other nationally recognized testing laboratories.

C. The formulas for calculating BTU or KW input listed in section VI.F. should be used when determining the minimum required size for a booster heater.

D. When a booster heater is installed below a drainboard, it shall be installed at least six inches above the floor and away from the wall, and in a manner that will allow accessibility for proper cleaning and servicing.

IX. RECIRCULATION PUMPS

A. Where fixtures are located more than sixty feet from the water heater, a recirculation pump must be installed, in order to ensure that water reaches the fixture at a temperature of at least 120° Fahrenheit.

B. In some cases it may be more practical to install a separate, smaller water heater for remote fixtures, such as for restroom handsinks.

X. INSTALLATION REQUIREMENTS

A. Where feasible, water heaters should be located in an area of the food facility separated from all food and utensil handling areas.

B. The Uniform Building Code prohibits the installation of gas water heaters in restrooms or change rooms.

C. Water heaters shall be mounted in one of the following manners:
   1. On six inch high, easily cleanable legs.
   2. On a four inch high coved curb base. All openings between the water heater and the base must be sealed in a watertight manner.
   3. On a properly finished and installed wall pedestal, positioned so that it is out of the work and traffic space.
   4. In an easily accessible location above a suspended ceiling. Where a permanently installed ladder is required to access the water heater, the ladder shall not be installed above a food or utensil handling area.

   Note: The local health agency may allow alternate installation methods when a water heater is installed in an area separated from food and utensil handling areas, such as in a mechanical room.

D. 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 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.

E. When multiple water heaters are connected, they must be installed in parallel, not in series (See Appendix IV).

APPENDIX I

HOURLY HOT WATER DEMAND TABLE

Utensil Sinks

18" X 18".....14 gallons per compartment

24" X 24".....25 gallons per compartment

Custom sink sizes can be calculated using the following formula:

Length X Width X Average Depth X 7.5 = gallons per compartment

Bar Sinks

6 gallons per compartment

Food Preparation Sinks

5 gallons per sink

Janitorial Sinks

15 gallons per sink

Garbage Can Wash Facility

15 gallons per facility

Hand Sinks

5 gallons per sink

Pre-rinse Units

Hand spray type.....45 gallons

Other types.....Refer to manufacturer's specifications for the equipment

Clothes Washers

9 and 12 pound washers.....45 gallons

16 pound washers.....60 gallons

Employee Shower

20 gallons per shower

Other Fixtures That Utilize Hot Water

Refer to manufacturer's specifications for the equipment

APPENDIX II

SIZING TABLE FOR GAS WATER HEATERS

Gallons Per Hour Delivery At Indicated Temperature Rise

BTU (X 1000)	40°F	50°F	60°F	70°F
5	11	9	8	6
10	23	18	15	13
15	34	27	23	19
20	45	36	30	26
25	56	45	38	32
30	68	54	45	39
35	79	63	53	45
40	90	72	60	51
45	101	81	68	58
50	113	90	75	64
55	124	99	83	71
60	135	108	90	77
65	146	117	98	84
70	158	126	105	90
75	169	135	113	96
80	180	144	120	103
85	191	153	128	109
90	203	162	135	116
95	214	171	143	122
100	225	180	150	129
105	236	189	158	135
110	248	198	165	141
115	259	207	173	148
120	270	216	180	154
125	281	225	188	161
130	293	234	195	167
135	304	243	203	174
140	315	252	210	180
145	326	261	218	187
150	338	270	225	193
155	349	279	233	199
160	360	288	240	206
165	371	297	248	212
170	383	306	255	219
175	394	315	263	225
180	405	324	270	232
185	416	333	278	238
190	428	342	285	244
195	439	351	293	251
200	450	360	300	257
205	461	369	308	264
210	473	378	315	270
215	484	387	323	277
220	495	396	330	283
225	506	405	338	289
230	518	414	345	296
235	529	423	353	302
240	540	432	360	309
245	551	441	368	315
250	563	450	375	322

APPENDIX III

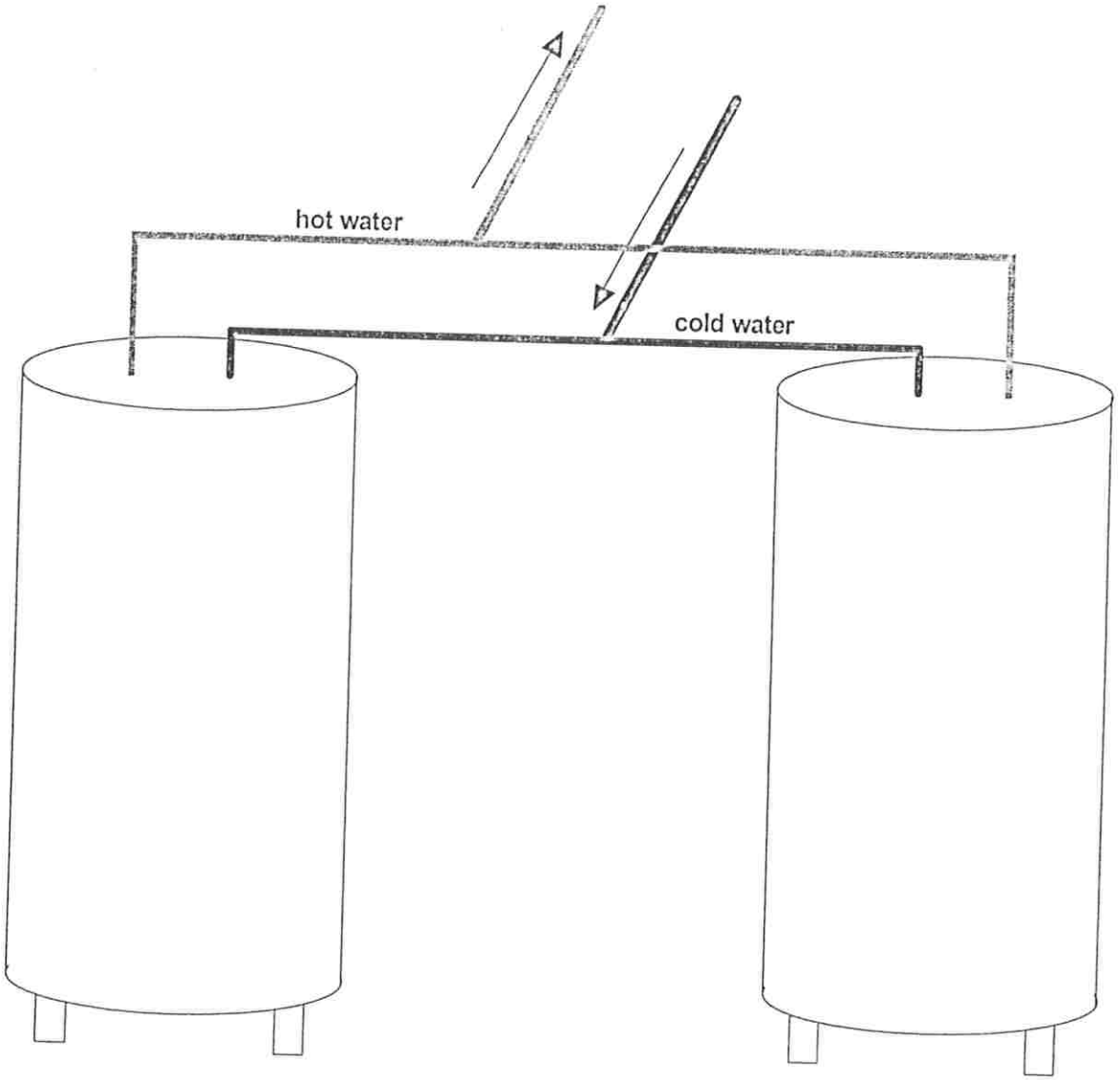
SIZING TABLE FOR ELECTRIC WATER HEATERS

Gallons Per Hour Delivery At Indicated Temperature Rise

KW	40°F	50°F	60°F	70°F
1	10	8	7	6
2	20	16	13	11
3	30	24	20	17
4	40	32	27	23
5	50	40	33	29
6	60	48	40	34
7	70	56	47	40
8	80	64	54	46
9	90	72	60	52
10	100	80	67	57
11	110	88	74	63
12	120	96	80	69
13	130	104	87	75
14	141	112	94	80
15	151	120	100	86
16	161	128	107	92
17	171	136	114	97
18	181	145	120	103
19	191	153	127	109
20	201	161	134	115
21	211	169	141	120
22	221	177	147	126
23	231	185	154	132
24	241	193	161	138
25	251	201	167	143
26	261	209	174	149
27	271	217	181	155
28	281	225	187	161
29	291	233	194	166
30	301	241	201	172
31	311	249	207	178
32	321	257	214	184
33	331	265	221	189
34	341	273	227	195
35	351	281	234	201
36	361	289	241	206
37	371	297	248	212
38	381	305	254	218
39	391	313	261	224
40	401	321	268	229
41	411	329	274	235
42	422	337	281	241
43	432	345	288	247
44	442	353	294	252
45	452	361	301	258
46	462	369	308	264
47	472	377	314	270
48	482	385	321	275
49	492	393	328	281
50	502	401	335	287

APPENDIX IV

Water Heaters Installed In Parallel



WATER HEATER WORKSHEET AND SAMPLE CALCULATIONS

Cited below, and on the next few pages, is information, and sample calculations from the North Carolina Department of Health, Food, Lodging, and Institutional Sanitation Branch.

DETERMINING HOT WATER SUPPLY REQUIREMENTS

The Food Service Advisory Committee has developed a uniform guideline for the sizing of hot water heaters for food service establishments. This guideline is used to insure uniformity on sizing of water heaters throughout the state and to insure food service establishments are provided with sufficient hot water for all operations.

The hot water heater should be sized as follows:

1. The minimum storage capacity for any establishment should be 50 gallons.

2. Hot water recovery is based on fixture requirements in accordance with the table on the next page.

3. A 100% degree-rise in temperature is used in calculating hot water recovery.

Hot Water Heater Size And Capacity

HOT WATER HEATER CALCULATION WORKSHEET					
EQUIPMENT	QUANTITY	TIMES	SIZE (in inches)	EQUALS	GPH
One-comp. sink See note #4		X	__by__by__	=	
Two-comp. sink See note #4		X	__by__by__	=	
Three-comp. sink See note #4		X	__by__by__	=	
Four-comp. sink See note #4		X	__by__by__	=	
One-comp Prep sink		X	5 GPH	=	
Two-comp Prep sink		X	10 GPH	=	
Three-comp Prep sink		X	15 GPH	=	
Three comp. bar sink See note #4		X	__by__by__	=	
Four comp. bar sink See note #4		X	__by__by__	=	
Hand sink		X	5 GPH	=	
Pre-rinse		X	45 GPH	=	
Can wash		X	10 GPH	=	
Mop sink		X	5 GPH	=	
**Dishmachine		X	Note #1	=	
**Cloth Washer		X	Note #2	=	
**Hose reels		X	Note #3	=	
Other equipment		X		=	

Other equipment		X		=	
Other equipment		X		=	
Total 140 F GPH (gallons per hour) Recovery Requirements Total =>					
Note - 140° F Hot water heaters are to be sized at the 140° F GPH recovery required at a temperature rise of 100° F.					

Note #1	Dishwasher (____ gals/hr. FINAL RINSE x 70%)
Note #2	Cloth Washer Calculation A. Limited Use/Cloth washer used one to two times per day; beginning or ending of day operation GPH = 60 GPH x 25%. B. Intermediate Use/Cloth washer used three to four times per day; GPH = 60 GPH x 45%. C. Heavy Use/Cloth washer used once every two hours; GPH = 60 GPH x 80%. D. Continuous Use/Cloth washer used every hour; GPH = 60 GPH x 100%.
Note #3	Hose reels @ 20 GPH for first reel & 10 GPH for each additional reel.
Note #4 GPH Requirements for sink	**GPH = (Sink size in cu.in. x 7.5 gal./cu.ft. x # compartments x .75 capacity)** **(1,728 cu.in./cu.ft.)**
Short version for above	GPH = Sink size in cu. in. X # compartments x .003255/cu. in. Example 24"x 24"x 14" x 3 compartments x .003255 = 79 GPH
Water heater storage capacity. (_____ Gallons Storage)	
Water heater recovery rate in gallons per hour at a 100°F temperature Rise. (_____Gallons per hour)	

SAMPLE CALCULATION

Three comp. sink --------	1	x	24x24x14	=	79
Two comp.Prep sink ----	2	x	10 GPH	=	20
Hand sink ----------	5	x	5 GPH	=	25
Pre-rinse ----------	1	x	45 GPH	=	45
Dishmachine ----------	1	x	Note #1	=	52
Can wash ----------	1	x	10 GPH	=	10
Mop sink ----------	1	x	5 GPH	=	5
Cloth Washer ----------	1	x	Note #2	=	27
Hose reel ----------	2	x	Note #3	=	30

Total GPH Requirement = 293 GPH

Note #1 - Dishmachine - Hobart AM-14 Final Rinse GPH = 74
Using Note #1 - 74 gal/hr Final Rinse x .70% = 51.8(= 52 GPH)

Note #2 - Cloth Washer used 4 times per day = 60 gal x 45% = 27 GPH

PART 10 - FINISH SCHEDULE

The following chart provides guidance for finishes for floors, walls and ceilings:

	FLOOR	WALL	CEILING
KITCHEN			
COOKING	Quarry tile; Poured seamless, sealed concrete	Stainless steel; Aluminum; Ceramic tile	Plastic coated or metal clad fiberboard; Dry-wall epoxy, Glazed surface; Plastic laminate
FOOD PREP	Same as above plus commercial grade vinyl composition tile.	Same as above plus approved wall panels (FRP) Fiberglass Reinforced Polyester Panel; epoxy painted drywall; filled block with epoxy paint or glazed surface	Same as above
BAR	Same as above	Same as above for areas behind sinks	Meets building codes
FOOD STORAGE	Same as above plus sealed concrete; commercial grade vinyl composition tile; or sheets	Approved wall panels (FRP) Fiberglass Reinforced Polyester Panel; epoxy painted drywall;filled block with epoxy paint or glazed surface	Acoustic tile; painted sheetrock
OTHER STORAGE	Same as above	Painted sheetrock	Same as above
TOILET ROOM	Quarry tile; poured sealed concrete; commercial grade vinyl composition tile or sheets	Approved wall panels (FRP) Fiberglass Reinforced Polyester Panel; epoxy painted drywall; filled block with epoxy paint or glazed surface	Plastic coated or metal clad fiberboard;dry-wall with epoxy; glazed surface; plastic laminate

	FLOOR	WALL	CEILING
DRESSING ROOMS	Same as above	Painted sheetrock	Same as above plus painted sheetrock
GARBAGE & REFUSE AREAS (Interior)	Quarry tile; poured seamless, sealed concrete; commercial grade vinyl composition tile or sheets	Approved wall Panels (FRP) Fiberglass Reinforced Polyester Panel; epoxy painted drywall;filled block with epoxy paint or glazed surface	Plastic coated or metal clad fiberboard;dry-wall with epoxy; glazed surface; plastic laminate
MOP SERVICE AREA	Quarry tile; poured seamless sealed concrete	Same as above	Same as above
WAREWASHING AREA	Same as above plus commercial grade vinyl compostion tile	Stainless steel; aluminum; approved wall panels (FRP) Fiberglass Reinforced Polyster Panel; epoxy painted drywall; filled block with epoxy paint or glazed surface	Same as above
WALK-IN REFRIGERATORS & FREEZERS	Quarry tile; stainless steel; poured sealed concrete; poured synthetic	Aluminum; stainless steel; enamel coated steel (or other corrosion resistant material)	Aluminum; stainless steel; enamel coated steel (or other corrosion resistant material)

Notes:

FLOORS

1. All floor coverings in food preparation, food storage, utensil-washing areas, walk-in refrigeration units, dressing rooms, locker rooms, toilet rooms and vestibules must be smooth, non-absorbent, easily cleanable and durable. Anti-slip floor covering may be used in high traffic areas only.

2. Any alternate materials not listed in the above chart must be submitted for evaluation.

3. There must be coving at base junctures that is compatible with both wall and floor coverings. The coving should provide at least 1/4 inch radius and 4" in height. See figure #10-1.

4. Properly installed, trapped floor drains shall be provided in floors that are water-flushed for cleaning or that receive discharges of water or other fluid waste from equipment, or in areas where pressure spray methods for cleaning equipment are used. Floors should be sloped to the drain at least 1/8" per foot.

5. Grouting should be non-absorbent and impregnated with epoxy, silicone, polyurethane or equivalent compound.

6. All walk-in refrigeration units, both with prefabricated floors and without, should be installed in accordance with the manufacturers' installation requirements.

WALLS

1. The walls, including non-supporting partitions, wall coverings and ceilings of walk-in refrigeration units, food preparation areas, equipment washing and utensil washing areas, toilet rooms and vestibules shall be smooth, non-absorbent, and capable of withstanding repeated washing. Light colors are recommended for walls and ceilings. Studs, joists and rafters shall not be exposed in walk-in refrigeration units, food preparation areas, equipment washing and utensil washing areas, toilet rooms and vestibules. Where permitted, exposed studs, joists and rafters must be finished to provide an easily cleanable surface.

2. All alternate materials not listed in the above chart must be submitted for evaluation.

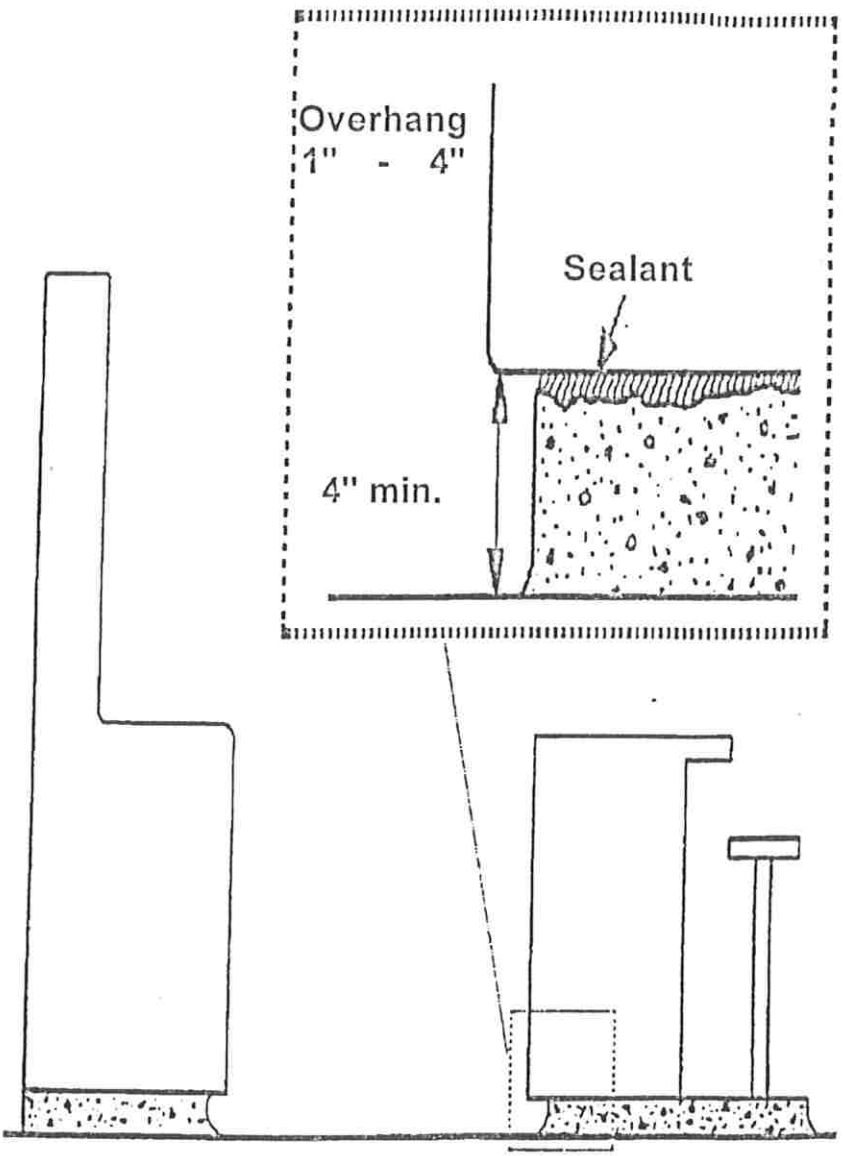
3. Glazed surfaces should be glazed block or brick, or ceramic tile. Grouting must be non-absorbent and impregnated with epoxy, silicone, polyurethane or an equivalent compound. Concrete block, if used, must be rendered non-porous and smooth by the application of an approved block filler followed by the application of an epoxy-type covering or equivalent. All mortar joints shall be only slightly tooled and suitably finished to render them easily cleanable.

4. Plastic laminated panels may find applications but are not recommended.

5. Joint finishes should be compatible with the wall structure. Voids should be eliminated at joints.

CEILINGS

Finishes shall be light-colored, smooth, non-absorbent and easily cleanable. Acoustical material free of porous cloth or sponge may be used, provided ventilation is adequate to minimize soiling.



Coving At Base Junctures

Figure 10-1

PART 11 - TOILET FACILITIES

Toilet facilities shall be installed according to law and shall be the number required by law. They shall be conveniently located and shall be accessible to employees at all times.

Toilets and urinals shall be designed to be easily cleanable and shall have integral backflow prevention devices as required by law.

Toilet rooms shall be completely enclosed and shall have tight fitting, self-closing, doors and should be vented to the outside if subject to odors.

Toilet facilities shall be of adequate number for customers, workers and handicapped. Toilet facilities shall be accessible in accordance with the Americans with Disabilities Act (ADA) of 1990.

PART 12 - PLUMBING AND CROSS CONNECTION CONTROL

Plumbing shall be sized and installed according to applicable codes. There shall be no cross connections between the potable water supply and any nonpotable or questionable water supply. Where nonpotable water systems are permitted for purposes such as air conditioning and fire protection, the nonpotable water must not contact directly or indirectly: food, potable water or equipment that contacts food or utensils. The piping of any nonpotable water system shall be durably identified so that it is readily distinguishable from piping that carries potable water.

SUBMERGED INLET PROTECTION

A cross connection is defined as any connection or structural arrangement between a potable water system and a non-potable source, liquid or otherwise, through which backflow can occur.

Backflow is defined as the flow of water or other liquids, mixtures, or substances into a potable water system from any source, other than the intended source.

A connection to a sewer line may be direct or indirect:

* A direct connection is a solid physical joining to a waste or soil line;

* An indirect connection is other than a solid physical joining to a waste or soil line (such as a submerged inlet).

An indirect connection may be one of two types:

* An air gap means the unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or outlet supplying fixture, or other device, and the flood level rim of the receptacle. The vertical physical separation shall be at least two times the inside diameter of the water inlet pipe above the flood rim level, but shall not be less than one inch.

* An air break is a piping arrangement in which a drain from a fixture, appliance, or device discharges indirectly into another fixture, receptacle or interception at a point below the flood level rim. The connection does not provide an unobstructed vertical distance through the free atmosphere and is not solidly connected, but precludes the possibility of backflow to a potable water source into a sink or dishwasher/or fixture being drained. See figure #12-5.

There shall be no cross connections between the potable water supply and any non-potable

water supply. The potable water system shall be installed to preclude the possibility of back flow and back siphonage. Devices shall be installed to protect against backflow and backsiphonage at all fixtures and equipment unless an air gap is provided. The air gap must be at least twice the diameter of the water supply inlet, but not less than 1", between the water supply inlet and the fixture's flood level rim. See figure #12-1 & 12-2.

The following provides examples of some of the types of equipment with potentially submerged inlets and required backflow/backsiphonage protection:

Equipment	Backflow/Backsiphonage Preventer Required in Lieu of Air Gap
1. Boiler with chemicals added	Reduced pressure device
2. Boiler with no chemicals added	Air vent type backflow preventer
3. Carbonators for beverage dispensers	Approved backflow preventer (in agreement with local plumbing codes)
4. Lawn sprinkler system with no chemicals added	Atmospheric or pressure vacuum breaker
5. Flush valve toilets	Atmospheric or pressure vacuum breaker
6. All hose bibs inside & outside of establishments	Hose bib-type vacuum breaker
7. Preflush hose with a nozzle head that may be submerged	Pressure vacuum breaker
8. Perforated pipe to oriental wok cookers	Atmospheric vacuum breaker
9. Inlets which are or may become submerged:	
a. Supply inlet to garbage grinder	Atmospheric vacuum breaker*
b. Supply inlet to dish table trough	" " "
c. Fill line for steam kettle	" " "

Backflow/Backsiphonage Preventer

Equipment	Required in Lieu of Air Gap
d. Supply line for mechanical warewashing machine	" " "
e. Supply line to all soap and chemical dispensing units on mechanical warewashing machine.	" " "
f. Garbage can washer	" " "
g. Soap portioner on faucet	Soap portioner must contain an internal air gap
h. Water wash system for exhaust hood	Air vent type backflow preventer (RPZ may be required if toxic chemicals are added)

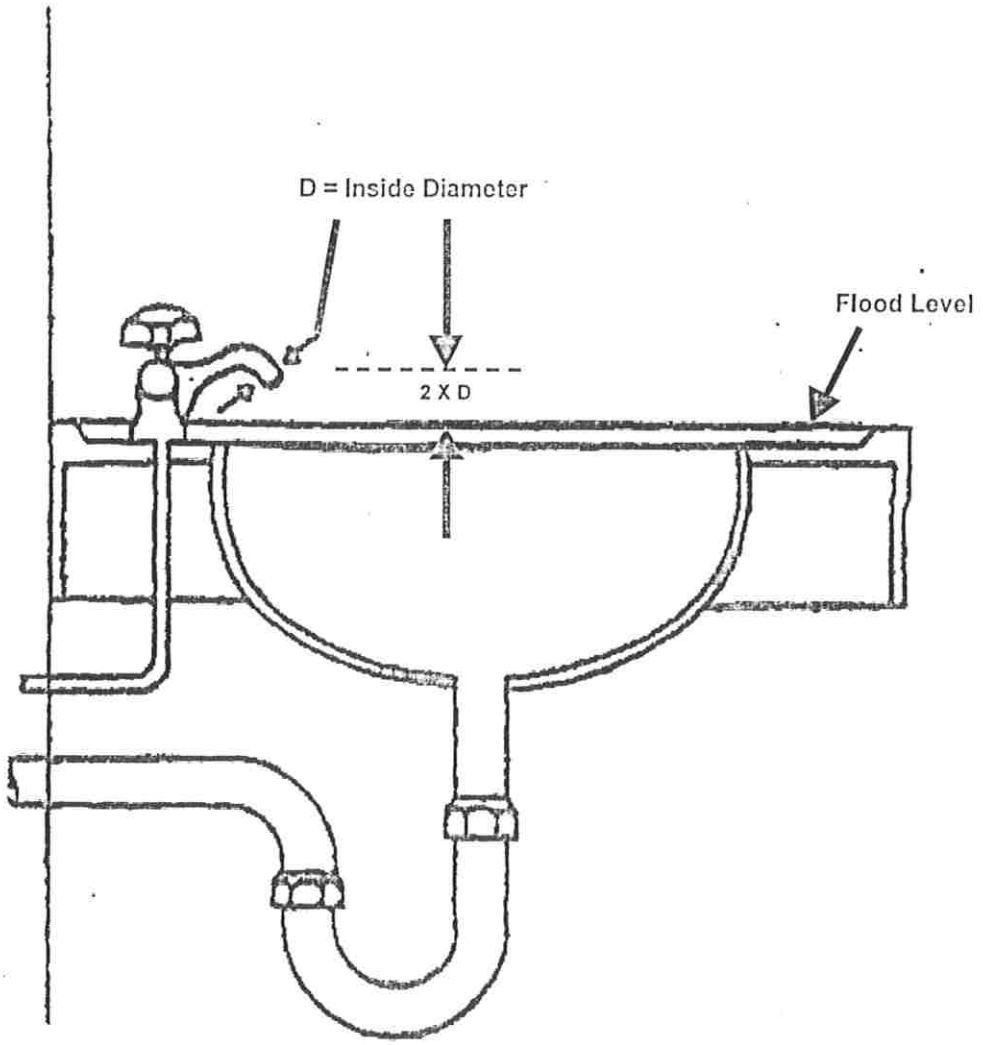
See figure #12-3 for examples of backflow/backsiphonage prevention devices.
*An atmospheric vacuum breaker means a mechanical device which automatically air vents a pipeline to prevent backsiphonage. The device shall be located beyond the last control valve prior to the first outlet and at an elevation 6 inches higher than any source of contamination. Atmospheric vacuum breakers shall be installed so that they are not subject to backpressure or continuous operating pressure of more than 12 hours duration.

DRAINS

A direct connection may not exist between the sewerage system and any drains originating from equipment in which food, portable equipment, or utensils are placed, except if otherwise required by state plumbing codes. When a warewashing machine is located within 5 feet of a trapped floor drain, the dishwasher waste outlet may be connected directly on the inlet side of a properly vented floor drain trap. See figure #12-4.

Other examples of required indirect drain line connections are:

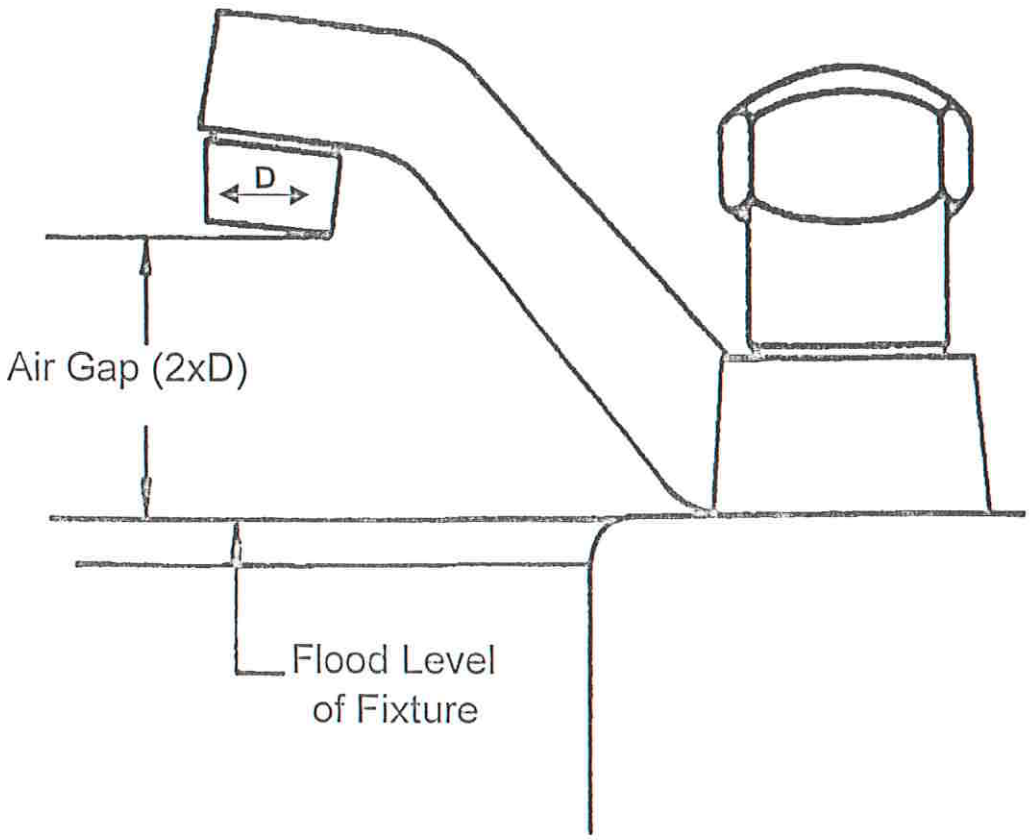
Equipment	Required Indirect Drain Line Connection to Sewer Line
1. Water-cooled condenser for ice machine or other refrigeration system	Air gap
2. Air-cooled condenser for ice machine or other refrigeration system	Air break
3. Ice bin	Air break



Air Gap On Lavatory

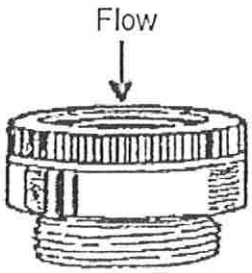
Figure 12-1

D= Inside Diameter

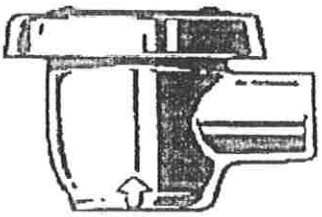


Air Gap And Effective Opening

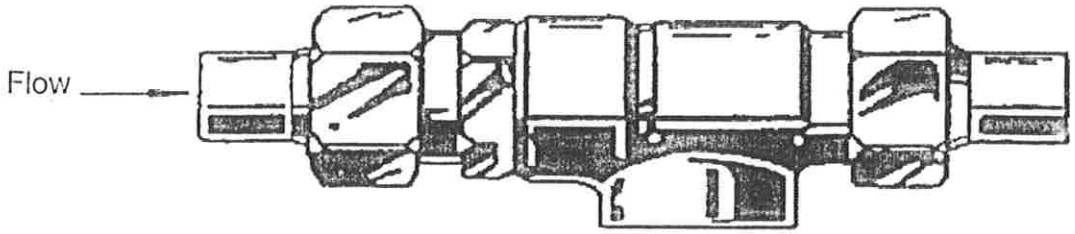
Figure 12-2



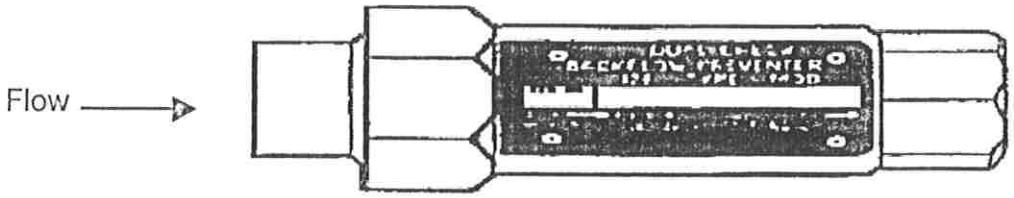
Hose Bibb Vacuum Breaker



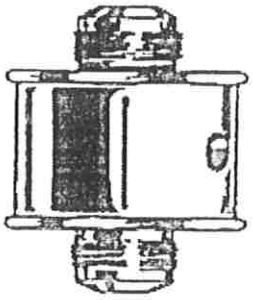
Atmospheric Vacuum Breaker



Backflow Preventer with Intermediate Vent



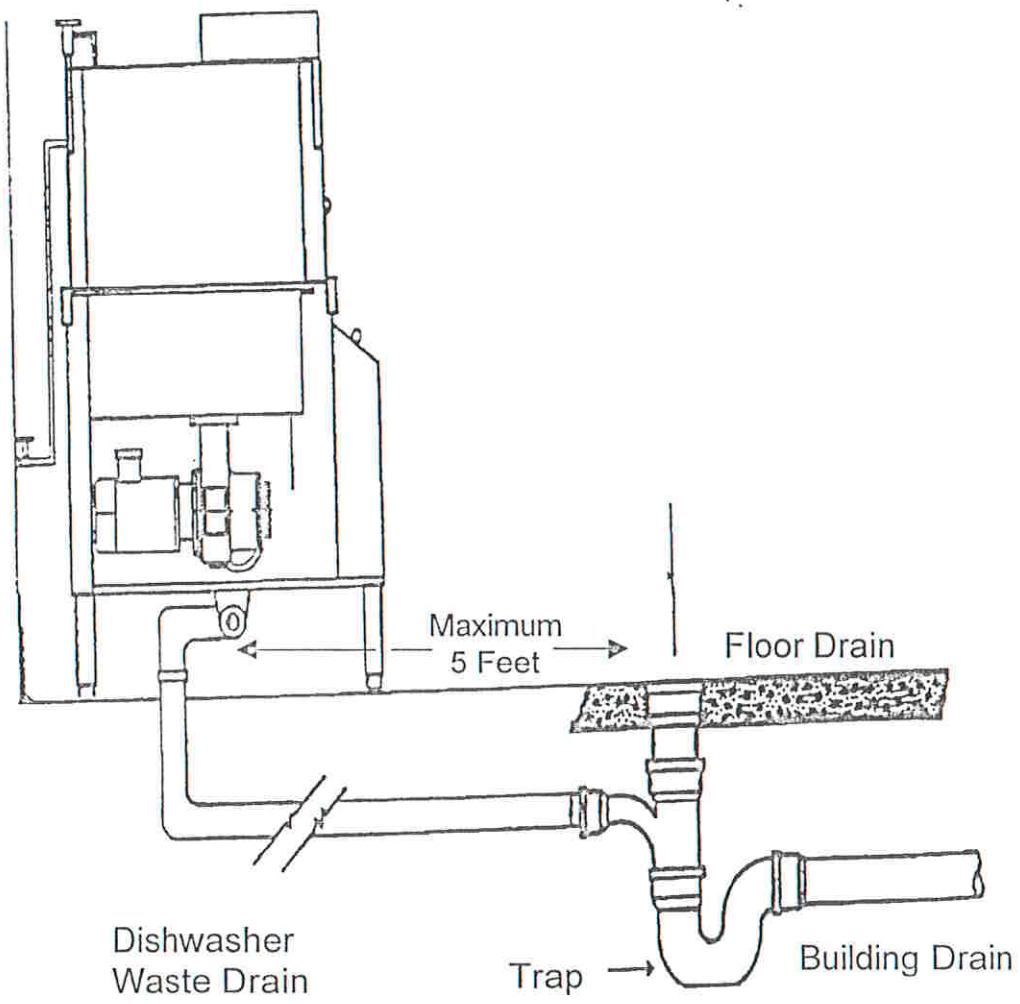
Dual Check Backflow Preventer



Carbonator Backflow Prevention

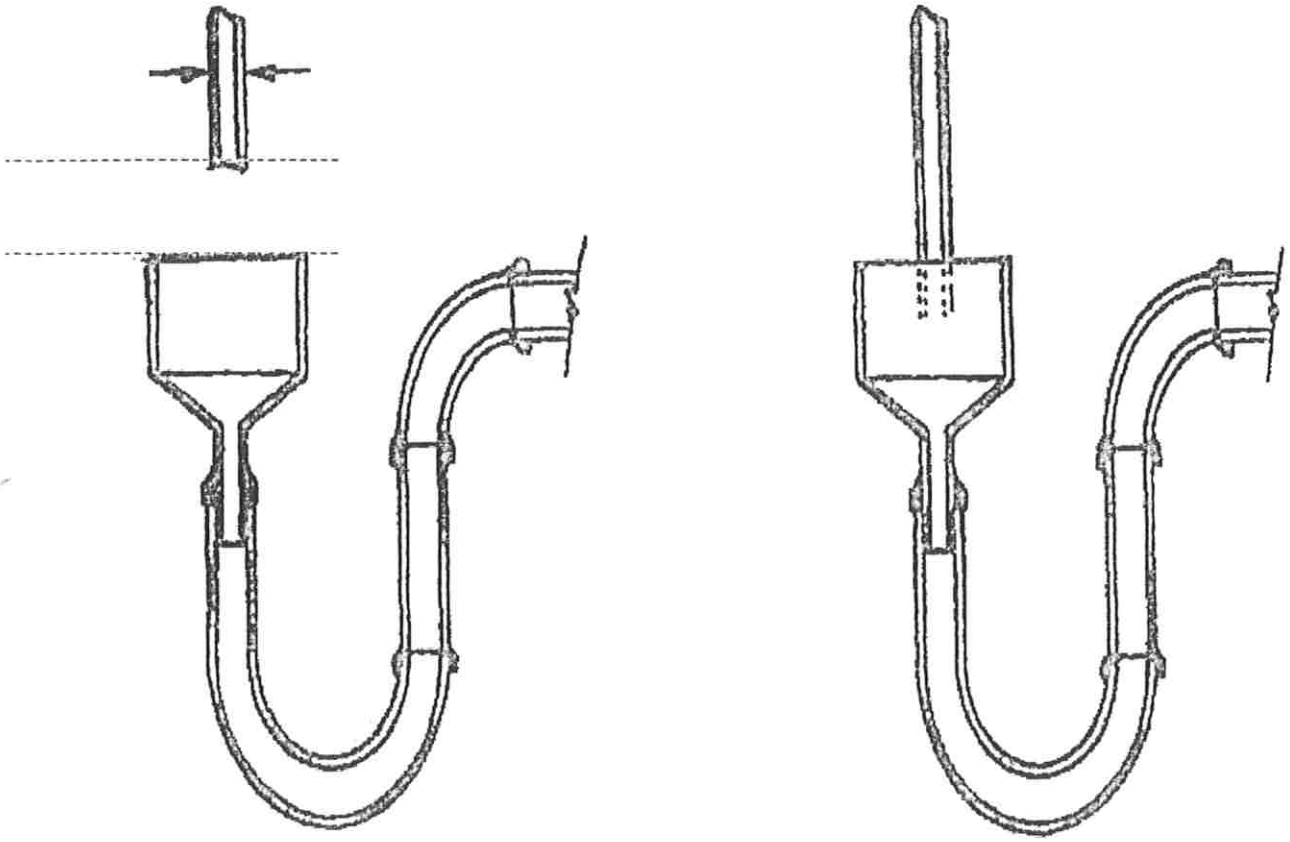
Backflow Prevention Devices

Figure 12-3



Warewashing Machine With A Direct Waste Connection

Figure 12-4



Air Gap

Air Break

Indirect Waste

Figure 12-5

PART 13 - INSECT AND RODENT CONTROL

Openings to the outside shall be effectively protected against the entrance of rodents. Openings to the outside shall be protected against the entrance of insects by the installation of tight fitting, self-closing doors; closed windows; self-closing serving windows at drive-throughs; screening; controlled air currents; vestibules; or other means approved by the regulatory health authority. Screen doors shall be self-closing and screens for windows, doors, skylights, transoms, intake air ducts and other openings to the outside shall be tight fitting and free of breaks. Screening material shall not be less than sixteen mesh to the inch. Openings around pipes, conduit or wiring entering the building from the outside must be sealed.

Loading docks and delivery doors must be provided with effective air curtains or vestibules with self-closing doors to preclude the entrance of insects. It is recommended that outside lighting around loading areas and entrances be sodium vapor rather than mercury vapor to decrease insect attraction.

All foundations shall be rodent proof. Openings between the floor and bottom of outer doors shall be adequately flashed with rodent proof material to eliminate any opening.

PART 14 - LIGHTING

The light intensity shall be at least 110 lux (10 foot candles) at a distance of 75 cm (30 inches) above the floor, in walk-in refrigeration units and dry food storage areas and in other areas and rooms during periods of cleaning.

The light intensity shall be at least 220 lux (20 foot candles) at a surface where food is provided for consumer self-service such as buffets and salad bars or where fresh produce or packaged foods are sold or offered for consumption; inside equipment such as reach-in and under-counter refrigerators; at a distance of 75 cm (30 inches) above the floor in areas used for handwashing, warewashing, and equipment and utensil storage, and in toilet rooms.

The light intensity shall be at least 540 lux (50 foot candles) at a surface where a food employee is working with food or working with utensils or equipment such as knives, slicers, grinders, or saws where employees safety is a factor.

Darker colored walls and floors may require additional lighting.

Shielding such as plastic shields, plastic sleeves with end caps, shatterproof bulbs and/or other approved devices shall be provided for all artificial lighting fixtures located in areas where there is exposed food; clean equipment, utensils, and linens; or unwrapped single-service and single-use articles.

Heat lamps, where permitted, shall be protected against breakage by a shield surrounding and extending beyond the bulb, leaving only the face of the bulb exposed.

PART 15 - VENTILATION

GENERAL

All rooms shall have sufficient ventilation to keep them free of excessive heat, steam, condensation, vapors, obnoxious odors, smoke and fumes. Ventilation systems shall be designed and installed according to law.

All hoods should be tested prior to use, to ensure the hoods exhaust adequately.

Lighting within the hood may be required to comply with state or local code requirements. If laundry dryers are used they should be vented to the outside.

COOKING

Cooking ventilation hoods and devices shall be designed and installed to prevent grease or condensation from collecting on walls, ceilings, and fire suppression supply piping and from dripping into food or onto food contact surfaces. See figure #15-1.

All hoods shall comply with the standards of an ANSI accredited certification program and be designed, constructed and installed in conformance with the National Fire Protection Association Bulletin #96 (The Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations), and other applicable fire safety codes.

Make up air intakes must be screened (bird screen) and filtered to prevent the entrance of dust, dirt, insects and other contaminating material. Where the introduction of make up air will cause condensation, drafting or interfere with the exhaust or vapor capture efficiency of the hood, the make up air must be tempered. A make up air system will be required if the exhaust is greater than 1500 cfm. Tempering of makeup air may be necessary in certain climates.

The installation of fire suppression system piping in the unfiltered air space in exhaust hoods should be limited to vertical runs as much as physically possible to minimize grease collection. Exposed piping must be cleanable.

HOT WATER SANITIZING DISHMACHINES

Hot water sanitizing dishwashing machines must be provided with adequate ventilation sized according to the dishwashing machine manufacturer's specifications.

The following information is provided to offer guidance in meeting the requirement for ventilating cooking equipment. There are several methods used in calculating the volume of air movement, measured in Cubic Feet per Minute (CFM), necessary to effectively and efficiently ventilate cooking equipment. While these methods are used in general applications, it must be noted that engineered exhaust systems which are customized for specific equipment under specific use conditions may also be approved by the building code official or fire marshall.

General Principles of Exhaust

The purpose of an exhaust hood is to provide a method of collecting, as nearly as possible, all of the grease produced from the cooking process, while furnishing a means of removing heat, smoke, and odors from the cooking area.

For the hood to fulfill its purpose there must be a sufficient volume of air movement (capture velocity) to draw grease particles and cooking vapors directly from the cooking surface to the grease extractors. This air flow removes cooking odors and keeps grease particles from settling onto nearby surfaces.

An effective capture velocity shall be sufficient to overcome opposing air currents, capture the grease and cooking vapors, and transport them directly to the grease extractors.

Grease extractors are ineffective in removing grease vapors. Only when grease vapors cool and condense can an extractor remove grease particles by directed air flow, contraction, and expansion (drop out). It is essential to have a sufficient volume of air flowing to cool and condense the grease vapors into grease particles prior to reaching the grease extractors.

Non-toxic smoke bombs may be used to evaluate and regulate kitchen exhaust hoods and supply systems. No fabricator of exhaust hoods can create all the conditions in the plant that the hood must cope with on the job site to function correctly.

In the case of heat and steam producing equipment, the purpose of the hood or ventilation system (such as a pants-leg duct system) is to control humidity, heat, and unwanted condensation.

A major cause of unacceptable hood performance is a lack of coordination between the Heating, Ventilation, and Air Conditioning (HVAC) system and the exhaust hood system. These systems should be coordinated prior to installation, and balanced when installation is completed, to ensure the proper performance of both.

Fire Protection

Exhaust ventilation systems for all grease producing cooking equipment is under the jurisdiction of the State Fire Marshal's Office and local fire and building officials. System designers and/or owners should contact these officials regarding fire safety plan review and inspection.

Hood Size

1. Canopy hoods and island hoods shall have a minimum depth of two feet and shall extend at least six inches beyond any equipment being ventilated, except that no overhang will be required on sides where aprons are installed. The dimensions of the hood are, in all cases, larger than the cooking surface to be covered by the hood. The amount of overhang of the hood depends upon the clearance or distance between the base of the hood and the top of the cooking equipment. A rule of thumb for the overhang on canopy hoods is 0.4 of the distance from the cooking surface to the bottom of the hood, but in any case, no less than six inches.

Example:

Hood overhang = distance from bottom of hood to top of range = 0.4 x 3.25 ft. = 1.30 ft., or approximately 1 foot, 4 inches

Canopy hoods shall be installed so that the bottom of the hood is between 6.5 feet and 7 feet above the finished floor.

(Figure 15-1 illustrates a canopy hood.)

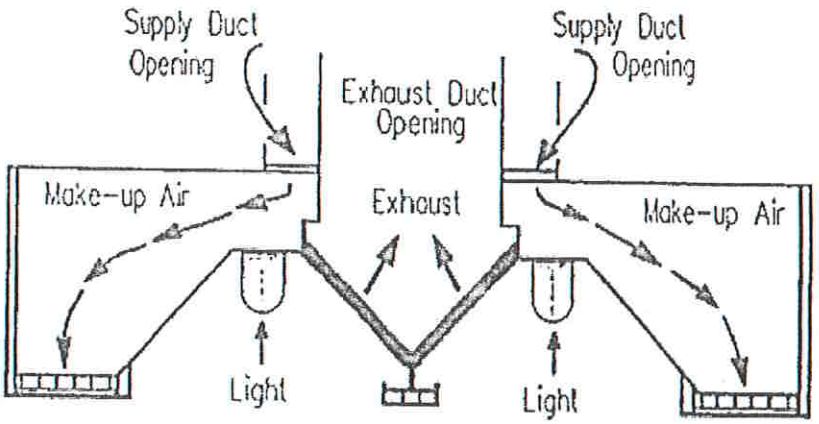


FIGURE 15-1

2. Ventilator, or "backshelf", hoods are designed to mount to the wall directly behind the cooking equipment. This type of hood is often used where ceiling height is a factor. It is normally placed closer to the cooking surfaces than a canopy hood, and works well in light to medium duty cooking applications. The ventilator hood is not recommended for charbroilers or similar high heat and grease producing cooking equipment. It does not have the capture area of a canopy hood and is not able to effectively handle large surges of cooking emissions (steam, heat, vapors, etc.)

   Several dimensions are essential in the proper installation of a ventilator hood. Ventilator hoods shall extend from the wall a minimum of 16 inches, and shall be installed so that the distance from the top of the cooking equipment to the bottom of the ventilator hood is no more than 24 inches. Equipment placed under a ventilator hood shall not extend beyond the sides of the hood or more than 36 inches from the back of the hood. These restrictions are necessary to ensure maximum capture and removal of cooking emissions.

(Figure 15-2 illustrates a ventilator hood.)

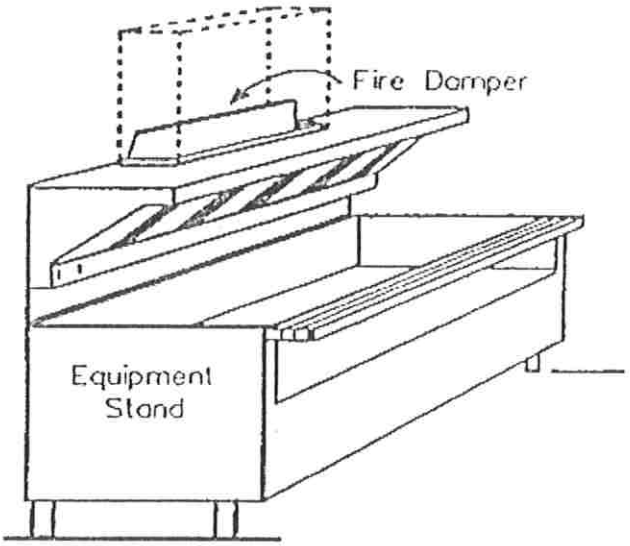


FIGURE 15-2

3. Pants-leg exhaust systems are designed to remove the heat or steam close to the point of discharge from warewashers or conveyor cooking equipment. These systems must be sized to effectively ventilate the equipment served.

(Figure 15-3 illustrates a pants-leg duct system.)

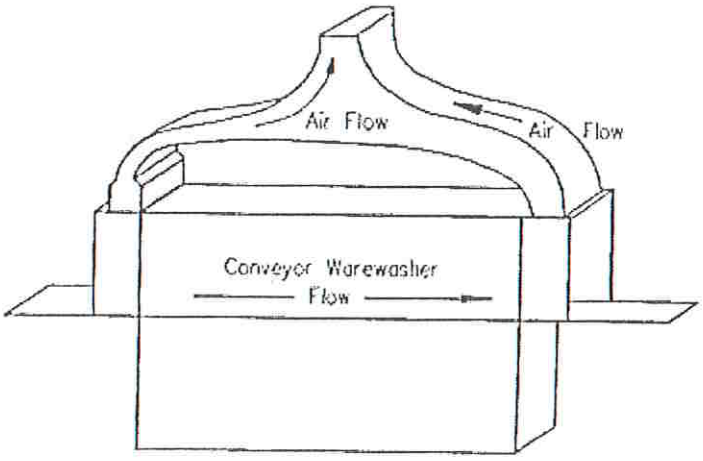


FIGURE 15-3

4. Eyebrow hoods are designed to immediately remove heat from an oven at the point of emission or as the door is opened. These hoods must effectively ventilate the door openings of the equipment served.

(Figure 15-4 illustrates an eyebrow hood.)

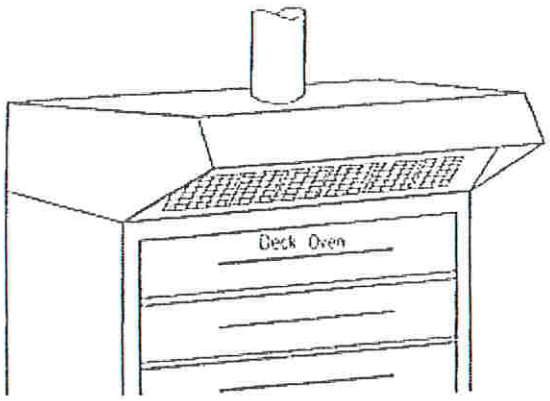


FIGURE 15-4

Exhausted Air

The amount of air exhausted through a hood exhaust system is dependent upon the size of the hood, its particular installation, and its use. There are several methods available for determining the amount of air to be exhausted. With the exception of systems engineered for specific equipment and specific applications that are approved by the health authority, the following criteria shall be used to calculate the amount of air exhausted:

1. Canopy hoods.

A. Standard square foot method.

This method of calculating exhaust air volume is based on the size of the opening in the hood (length x width) and the capture velocity relative to the installation of the hood (see Table I).

Hood length x hood width = square feet ($ft.^2$) of hood opening.

$Ft.^2$ of hood opening x factor from Table I = CFM of air exhausted.

TABLE I.

Exposed sides	Factor($CFM/ft.^2$)
4 (central island hood)	125
3 (wall hung hood)	100
2 (corner hung hood, or with aprons)	85
Steam or heat exhaust only	70

Example:

8 ft. (length) x 4 ft. (width) = 32 $ft.^2$
32 $ft.^2$ X 100 $CFM/ft.^2$ (wall hung hood) = 3200 CFM

B. Exposed linear foot method.

This method of calculating the exhaust air volume is based on the total exposed linear footage of the hood and the capture velocity relative to its application (see Table II).

Exposed linear footage of hood x factor from Table II = CFM of air exhausted.

TABLE II

Application Factor (CFM/in. ft.)

Light duty (no grease, light grease)	150 - 250
Medium duty (fryers and griddles)	250 - 350
Heavy duty (heavy grease, charbroiler)	350+

Example:

4 ft. x 8 ft. hood (light grease), 3 exposed sides

4 ft. + 8 ft. + 4 ft. = 16 exposed linear ft.

16 exposed linear ft. x 250 CFM/linear ft. = 4000 CFM

C. Square feet of cooking surface method.

This calculation of the volume of exhausted air depends on the size, temperature, and design of the cooking equipment and the minimal capture velocity required to keep smoke, vapors, and fumes under the hood. The amount of air to be removed is calculated by multiplying the surface area of the equipment (f t.^{2}) by the appropriate updraft velocity factor (see Table III); total air exhausted is the sum of exhaust air volumes of all the equipment added to the minimal capture velocity.

Ft.^{2} of cooking surface of each piece of equipment (length x width) x the updraft velocity factor from Table III = CFM of exhaust required for each piece of equipment.

TABLE III.

Application	Updraft velocity factor
Steam kettles, ranges, ovens, non-grease producing equipment	50 fpm
Fryers/griddles, grease Producing equipment	85 fpm
Charbroilers, high heat and grease producing equipment	150 fpm