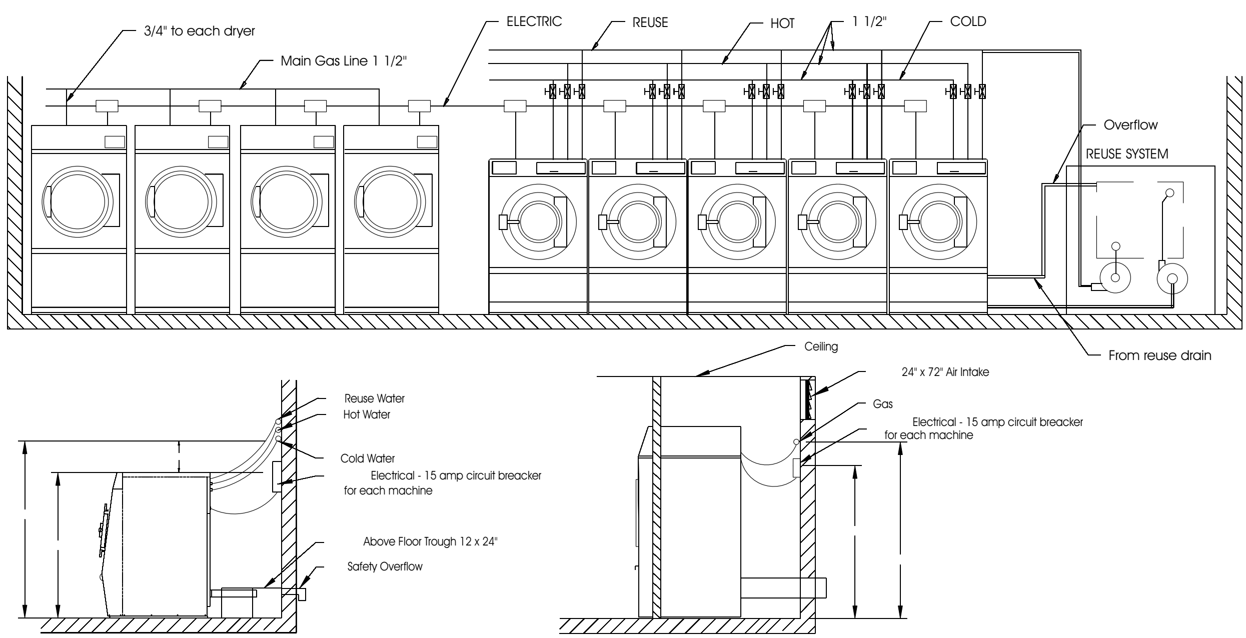
Laundry Planning Handbook



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Calculations and Formulae

Cylinder Volume

Volume measures the physical size of cylinder (or basket). It is the best way to compare rated capacities of competitive machines. The larger the volume, the more laundry the machine's cylinder can hold. It is calculated as follows:

3.14 * R^2 (radius of cylinder in feet squared) x depth of cylinder / 1728 = volume of cylinder in cubic feet.

The accepted capacity for washer-extractors is between 5 and 7 lb. per cubic foot. Accepted capacity for dryers is between 2.5 and 3.5 lb. per cubic foot.

Volume refers to the available area within the basket or cylinder of the washer. Here are some relationships between volume in cubic feet, gallons and liters.

1.0 cubic foot = 7.48 gallons = 28.27 liters
0.134 cubic foot = 1.0 gallons = 3.78 liters

G-Force

G-Force is a relative measurement used to compare a washer's extraction capabilities (spin speeds). Higher G-forces lead to less water being left in the goods after the wash program is complete, leading to shorter drying times and reduced energy consumption to dry the goods. Comparatively, higher RPM's relate to higher G-Force when the cylinder size is similar. However, larger diameter cylinders can spin slower, yet attain a higher G-Force than smaller diameter cylinders. Here's the formula to calculate G-Force:

RPM^2 x diameter (inches) / 70,500 = "G" Force

Water Data

Here is some specific data on water:

About 50-60% of water used in a typical laundry formula is hot
(if a conventional water system is used).

1 cu. ft. of water = 62.425 lb.
1 cu. ft of water = 7.48 gallons
gallon(s) x .1336 = cubic feet
gallon(s) x 231 = cubic inches

Calculations and Formulae

pound of water x .016 = cubic foot
pound of water x .12 = gallons
1 gallon = 8.33 lb. @ 62 degrees Fahrenheit (°F)
Boiling water = 212 Fahrenheit (°F) = 100 Celsius (°C)
Freezing water = 32 Fahrenheit (°F) = 0 Celsius (°C)

To convert to °F; multiply °C by 9, divide by 5, and add 32.
To convert to °C; subtract °F by 32, multiply by 5, and divide by 9.

Moisture Retention

Moisture retention measures the water extracted from the load. The more water removed from the load, the less drying time is required, thereby reducing drying times and saving energy. Too much water removal, however, can damage fabrics. A certain amount of water retention is required for finishing procedures. To calculate moisture retention, use the following formula:

Weight after extraction - dry weight / dry weight = Moisture Retention (%)

Water Hardness

More tallow soap is required for washing in hard water than in soft water. A water softener may be required if grains/gallon of hardness exceed 3.

Water Hardness definitions:

Grains/Gallon	Parts/Million	Description
less than 1.0	less than 17.1	soft
1.0 to 3.5	17.2 to 60	slightly hard
3.6 to 7.0	61 to 120	moderately hard
7.1 to 10.5	121 to 180	hard
10.6 & over	181 & over	very hard

Electricity

horsepower x .7457 = kW
watt/hour x 3.413 = BTU
1 kWh = 3413 BTU = 1 kW x number of hours operated

To calculate approximate electrical consumption, use the following formula for each motor in the laundry (then total the results for all motors):

V x I x 1.7321 x PF /1000 x # of hours operated per day = kW/day

where: V = voltage (volts); I = current (amps); PF = power factor

As a rule of thumb, assume motors are running under a constant load, yeilding a power factor of about 0.80. Inverter driven equipment typically has a power factor of 0.9.

Gas Data

A BTU is the amount of heat required to raise one pound of water approximately one degree Fahrenheit (°F):

> one Therm (TH) = 100,000 BTU
> one cubic foot = 1,000 BTU (approx..)
> one MCF (1,000 cubic feet) = 10 Therms (approx..)
> one cubic foot of Butane gas = 3,200 BTU
> one gallon No. 2 diesel fuel oil = 139,500 BTU (approx.)
> one gallon No. 6 fuel oil = 149,000 BTU (approx.)
> one kilowatt (kW) = 3,415 BTU
> one gallon propane = 92,000 BTU

Gas cost : The cost of gas is usually stated in the price per therm or price per M or MCF (1,000 cubic feet). In computing costs, the actual total to the end user should be used, and divided by the number of therms used to find the cost per therm. Various rate structures are used by local gas suppliers. These include " straight line" rates, and "block" rates in which the rate varies for various quantities. Additional charges such as "demand charge", "commodity charge", or "service charge" may also be part of the gas cost. Any charge the customer may pay to receive gas, including sales tax where applicable, should be included in the total gas cost from which the actual cost per therm is derived.

Boiler Horsepower

one BHP = the work of converting 34.5 lb. of water (at 212 °F) per hour to steam at 0 lb. gauge pressure.

one BHP = 33,500 BTU/hr
one BHP = 34.5 lb./steam
one BHP = 9.803 kilowatts

Laundry Sizing

Sizing Washer Extractors

Motels/Hotels and Resorts
one bed per room in economy hotel:
8 lb./day x rooms x 7 days x occupancy % / 40 hours = lb./hr.

two beds per room in economy hotel:
14 lb./day x rooms x 7 days x occupancy % / 40 hours = lb./hr.

one bed per room in luxury hotel or resort:
11 lb./day x rooms x 7 days x occupancy % / 50 hours = lb./hr.

two beds per room in luxury hotel or resort:
20 lb./day x rooms x 7 days x occupancy % / 50 hours = lb./hr.

With larger facilities, increase poundage because of pool, spa, fitness, banquet and/or dining facilities used by both guests and non-guests. Use the following guidelines:

Restaurant & Banquet items: 0.31 lb per cover
Terry Robes: 1.2 lb per room per day
Pool/Spa towels: up to 2 lb per item

If the double occupancy rate is known, multiply the lb/hr rate the double occupancy increase:

Double Occupancy increase = 1 + 0.6 x Double Occupancy Rate

Assume laundry to process 1.2 - 1.5 loads per hour.

Nursing Homes
50 lb./bed/week x number of beds / 37.5 hr. = lb./hr

This includes patient clothing in the average home. If a higher number of incontinent patients, increase the per bed per week poundage to 60 lb.

Assume laundry to process 1.0 - 1.3 loads per hour.

Hospitals
15 lb./day x number of beds x 7 days / 37.5 hr. = lb./hr

Assume laundry to process 1.0 - 1.3 loads per hour.

Laundry Sizing

For the division of work, assume 60% flat work (i.e.: sheets), 40% fluff/dry.

Correctional Facilities
6 lb./day x number of inmates x 7 days / 50 hours = lb./hr.

Assume laundry to process 1.3 loads per hour.

Shirt Laundry / Dry Cleaning Plant
1/2 lb.x number of shirts/day x 6 days / 40 hours = lb./hr.

Assume washer to process 1.2 - 1.5 loads per hour.

Typical Dry Weights

Item	Weight, lbs.	Item	Weight, lbs.
King-size sheet	2.3	Pants, cotton	1.3
Queen-size sheet	1.9	Shirt, cotton	0.7
Double bed sheet	1.8	Dress uniform	0.9
Single bed sheet	1.5	Jacket (waiter)	1.4
Pillow case	0.3	Apron (waitress)	0.1
Table Cloth (54" x 54")	0.7	Apron (bibbed)	0.5
Table Cloth (54" x 96")	1.4	Apron (waist)	0.4
Table Cloth (45" x 45")	0.5	Apron (shop)	0.7
Table Cloth (64" x 64")	1.0	Coverall, lighweight	2.2
Banquet cover (54" x 120")	3.0	Coverall, flame retardant	2.8
Napkin (20" x 20")	0.1	Coat, laboratory	1.2
Hand towel (17" x 26")	0.2	Coat, utility	2.5
Bath Towel (24" x 44")	0.5	Gown, patient's	0.6
Wash cloth (12" x 12")	0.1	Gown, surgical	0.9
Bath Mat (terry)	0.6	Mop head	1.5
Bath Mat (heavy)	1.4	Cap, chef's	0.1
Blanket (84" x 110")	4.2	Gloves, cotton	0.5
Bedspread (84" x 118")	4.7	Gloves, canvas	0.8
Bedpad (60" x 76")	2.8	Diapers (baby)	0.06-0.12
Smocks (cotton)	3.3	Smocks (blend)	1.1
Coverall (freezer)	5.0	Gloves	0.5-0.75
Draw sheet (63" x 99")	1.2	Dust mop, 36"	1.5
Turnout gear coat	6.0	Turnout gear bunker	5.0
Turnout gear gloves (leather)	0.8	Turnout nomex hood	0.2
Fire station duty shirt	1.0	Fire station duty pants	1.5
Fire station workout sweat pants	8.0	Fire station workout sweatshirt	1.3

Laundry Sizing

Sizing Dryers

Dryer should be of larger capacity than corresponding washer-extractor. Estimate between 1.2 and 1.4 times washer-extractor capacity. (i.e.: a 65 lb. washer requires approximately a 75 lb. dryer).

Average loads per hour
gas fired = 2
steam heated = 1.5
electric heated = 1

In general, the 1.2 - 1.4 capacity rule applies to washer with high spin speeds (g-force greater than 200 G's). If low or medium speed (80-180 G's) are used, a dryer to washer ratio should be 2:1. Thus, a 50 lb. washer would require a 100 lb. dryer. If part of the volume of laundry is to be ironed, dryer capacity can be reduced.

Time for drying a load can be estimated with the following formula:

$$\text{Drying time (hrs.)} = \frac{\text{(Load weight, lbs) x (\% water retention) x (2500 BTU/lb)}}{\text{(BTU per hour rating of dryer)}}$$

Under ideal conditions, it takes about 1200 BTU to evaporate 1 pound of water. Since a dryer is not 100% efficient, we use 2500 BTU/lb to make up for any inefficiencies.

It is usually best to enclose the dryers to separate the make up air supply. This is especially true if the laundry will have air conditioning or some other environmental control. Dryer enclosures provide two significant benefits:

- The dryers will not use conditioned air from the room for make-up air. This will reduce operating expenses, since the dryer is not taking cooler room air and heating it to 160 to 180 degrees.

- Heat emission is reduced by up to 80%. A good rule of thumb is that a dryer will emit 2% of its rated BTU's through each exposed face. Thus, if a dryer is unexposed, there are 5 faces radiating heat into the room (the front, sides, rear and top). The total emission is then 10% of the rated BTU! By enclosing the same dryer, heat emission is reduced to only 2%.

Noise from the mechanical components of the dryer is also reduced by the enclosure. There are occasions when enclosing the dryers is not suitable, so use good judgement for each situation. When enclosing dryers, always provide enough space for service at the rear of the equipment. Most importantly, always provide a properly sized make up air source. A good rule of thumb for makeup air is 1 square inch of clear opening for each 800 BTU of heat. Check local codes for exact requirements. If a louver or screen is to be used, the opening should be at least doubled, since the device will restrict at least half of the opening.

Sizing Gas Water Heaters

To determine the quantity of hot water requirements per hour:

An excellent rule of thumb is to allow 2 gallons of hot water per hour per pound of washer capacity.

Determine temperature of incoming water. Subtract this from the desired hot water level to arrive at the degree of temperature rise.

Formula: (gallons hot/hr x 8.3 (lb./gal) x Temperature rise) / .7 (efficiency factor)= BTU/hr

Example:
100 gal/hr x 8.3 (lb./gal) x 100 F rise / .6 = 138,333 BTU/hr

If heating with steam, divide by 33,500 BTU/BHP.
If heating with electric, divide by 3413 to determine the kW rating.
Storage capacity should equal from 1/2 to 1 hour's demand.

On Demand Water Heaters

A demand water heater for a commercial/industrial washer isn't recommended.

The machines are equipped with large inlet valves which flow at a high rate (3/4" - 22gpm, 1" - 39gpm, 1-1/4" - 100gpm). Slower fill times are possible, but not usually acceptable, as the machine typically fills 5 times each wash program, and extremely long fill times kill the productivity of the machine.

Hot water usage can be as twice as much as the capacity of the machine per hour (60 lb machine uses 120 gallons of hot water per hour), depending upon the industry (this is especially true in health care).

For planning purposes, a front load washer will consume 2 gallons of water per pound of capacity per load, about half of which is hot. You can count on up to 1.5 cycles per hour if the machine can fill and drain as it was designed.

Laundry Sizing

Sizing Water Softeners

Determine grain hardness (3 grains acceptable without softening).
Determine total gallons of water to be used per hour.
Multiply grains hardness x total gallons x hours of operation between regeneration (backwashing).

Example:
20 grains x 1000 gallons x 24 hours = 480,000 grain softener

Check the flow rate of softener, and make sure it is adequate.

Sizing Air Compressors

Add up CFM requirements on all air driven equipment.
Add an additional 25% to CFM.
Tank size should be 3 to 5 times the CFM output in gallons of storage.
Example:
Required 20 CFM + 25% = 25 CFM
Tank should be 75 - 125 gallon size.

Sizing Boilers

Find the BHP rating on each piece of equipment in the operation that requires steam. If pounds of steam consumption is known (in place of BHP), divide by 34.5 to get BHP.

To all BHP requirements, add 10% of the total for heat loss/radiation and divide by 0.7 (this allows for efficiency factor and keeps you from operating the boiler at full capacity, which is both costly and harmful to the boiler).

Sizing Drain Troughs

Determine the total number of gallons to be dumped at one time by all present and future machines. Use high level rinse figures to get this total.

Divide total gallons by 7.48 gallons/cubic foot to get the total cubic feet required.
Example:
300 gallons / 7.48 = 40 cubic feet of trough area

The trough depth should usually be 12 inches, and the width 14 inches.

Laundry Sizing

In the example above, assume a 12 inch deep and 14 inches wide trough:

14" x 12" = 168 sq. inches

168/144 (one sq. ft.) = 1.166 sq. feet (trough area)

40 (cubic feet required) / 1.166 = 34.3 feet (length of trough)

Drain trough should slope 1/4" per linear foot to the outlet drain. On long troughs, this can be decreased to 1/8" per linear foot to keep the depth from becoming too great.

See Chart below for specific fill volume information. The numbers shown are levels with no goods loaded into the machine.

Water Consumption Data

Machine	Low				Med				High			
HE-30/35	8 cm	3.0 in	3.4 gal	12.8 l	13 cm	5.0 in	7.5 gal	28.5 l	18 cm	7.0 in	11.5 gal	43.5 l
HE-40/45	6 cm	2.5 in	3.4 gal	12.9 l	14 cm	5.5 in	10.1 gal	38.3 l	23 cm	9.0 in	18.6 gal	70.6 l
HE-60/65	5 cm	2.0 in	3.3 gal	12.6 l	14 cm	5.5 in	12.6 gal	47.8 l	24 cm	9.5 in	25.0 gal	94.4 l
HE-80/85	8 cm	3.0 in	5.4 gal	20.5 l	14 cm	5.5 in	11.0 gal	41.7 l	27 cm	10.5 in	28.0 gal	105.9 l
SP-40/45	16 cm	6.4 in	6.4 gal	24.4 l	23 cm	9.1 in	12.8 gal	48.5 l	30 cm	11.7 in	20.2 gal	76.4 l
SP-60/65	18 cm	7.0 in	9.1 gal	34.4 l	26 cm	10.1 in	18.5 gal	70.1 l	34 cm	13.2 in	29.5 gal	111.5 l
SP-100/110	20 cm	7.9 in	14.5 gal	54.7 l	30 cm	11.6 in	29.0 gal	109.8 l	39 cm	15.3 in	45.9 gal	173.7 l
SP-130/135	24 cm	9.5 in	25.4 gal	96.2 l	31 cm	12.2 in	52.8 gal	199.9 l	41 cm	16.1 in	84.5 gal	320.0 l
SP-155/165	24 cm	9.5 in	31.4 gal	118.8 l	31 cm	12.2 in	64.6 gal	244.5 l	41 cm	16.1 in	103.0 gal	390.1 l
SP-185/195	28 cm	11.0 in	34.1 gal	129.0 l	39 cm	15.4 in	70.4 gal	266.4 l	51 cm	20.1 in	112.5 gal	425.8 l
SB-60	18 cm	7.1 in	9.1 gal	34.4 l	26 cm	10.2 in	18.5 gal	70.1 l	34 cm	13.4 in	29.5 gal	111.5 l
SB-80	19 cm	7.5 in	12.0 gal	45.5 l	28 cm	11.0 in	23.7 gal	89.8 l	36 cm	14.2 in	37.3 gal	141.1 l
SB-155	24 cm	9.5 in	31.4 gal	118.8 l	31 cm	12.2 in	64.6 gal	244.5 l	41 cm	16.1 in	103.0 gal	390.1 l
SB-225	28 cm	11.0 in	41.4 gal	156.6 l	41 cm	16.1 in	86.2 gal	326.3 l	53 cm	20.9 in	138.2 gal	523.0 l
SB-300	30 cm	11.8 in	41.6 gal	157.7 l	43 cm	16.9 in	85.6 gal	324.2 l	56 cm	22.1 in	136.6 gal	517.3 l
SB-480	34 cm	13.4 in	62.4 gal	236.3 l	51 cm	20.1 in	128.4 gal	486.0 l	67 cm	26.4 in	204.8 gal	775.4 l
SI-110	24 cm	9.5 in	16.1 gal	61.1 l	34 cm	13.2 in	31.5 gal	119.3 l	43 cm	16.9 in	49.3 gal	186.7 l
SI-135	26 cm	10.4 in	19.6 gal	74.3 l	37 cm	14.7 in	39.1 gal	147.9 l	48 cm	19.0 in	61.6 gal	233.2 l
SI-200	28 cm	10.8 in	29.2 gal	110.6 l	39 cm	15.4 in	58.7 gal	222.1 l	51 cm	20.0 in	92.8 gal	351.4 l
SI-275	30 cm	11.7 in	38.2 gal	144.6 l	43 cm	16.9 in	78.2 gal	295.9 l	56 cm	22.1 in	124.5 gal	471.3 l
SI-300	30 cm	11.7 in	42.6 gal	161.4 l	43 cm	16.9 in	86.6 gal	328.0 l	56 cm	22.1 in	137.6 gal	521.0 l
SA-475	34 cm	13.6 in	62.4 gal	236.3 l	51 cm	20.0 in	128.4 gal	486.0 l	67 cm	26.4 in	204.8 gal	775.4 l
HP-60/65	18 cm	7.0 in	9.1 gal	34.4 l	26 cm	10.1 in	18.5 gal	70.1 l	34 cm	13.2 in	29.5 gal	111.5 l
HP/HI-85	24 cm	9.3 in	12.7 gal	48.0 l	33 cm	12.9 in	25.8 gal	97.5 l	42 cm	16.5 in	40.9 gal	154.9 l
HP/HI-125	26 cm	10.2 in	18.4 gal	69.8 l	37 cm	14.4 in	37.6 gal	142.5 l	47 cm	18.5 in	59.9 gal	226.7 l

Laundry Sizing

Laundry Cart Sizing

Select the proper cart sizes to match the washer-extractors. Matching the carts to the washers makes it easy to get a full washer load of soiled goods without using a scale. Use the chart to find cart sizes.

Laundy Cart Capacities

Cart Size	Dimensions	Cart Capacity (lbs)		
Bushels	L x W x D	Dry Soiled	Wet	Folded
2	22 x 14 x 14	12	25	30
4	30 x 18 x 16	20	40	48
6	30 x 20 x 20.5	37	75	89
8	34 x 22 x 23	49	99	119
10	36 x 24 x 25	62	124	149
12	36 x 26 x 27.5	75	149	179
14	40 x 28 x 27.5	87	175	209
16	40 x 28 x 30	99	199	237
18	42 x 30 x 30	112	224	268
20	44 x 32 x 33	124	249	298

Labor Requirements

Use the following guidelines to determine the number of full time employees a given laundry could require:

For a laundry with less than 125 pounds of capacity, provide 1 full time employee for every 50 pounds of washer capacity.

Far a laundry with more than 125 pounds of capacity, provide 1 full time employee for every 75 pounds of washer capacity.

These guidelines are for estimation only, since laundry operations can have lower and higher efficiencies. Automation, management, finishing equipment and other variables can have significant effects on labor requirements. Good judgement should be used in all cases!

Laundry Sizing

Check List

Here is a 10 point check list to consider when laying out your new laundry.

1. Space available:_____ x _____ Ceiling height: ____ Door height: ____ Door width: ____
2. Floor type: ______________ Concrete thickness: ______
   Concrete Pad needed:_____ Floor condition __________
3. Floor Location: _____ Above ground; _____ Basement or ground level
4. Loading dock: _______ Steps: _______ Rigging required: _____
   Length of run to location: ________________
5. Electrical Service: Voltage: ______ Phase: ______ Available Amps: _____
   Location of power: _____________________ Need to run new line?: _____
6. Gas service: _____natural; _____propane; _____ butane. BTU/cu.ft.: ________
   Work needed: ____
7. Water: Size of line: ____ Hot water capacity: ____gal/hour; Hardenss/grain: ____
8. Drain: Size: ____ Gravity?: _____ Sump pump?: ________
   Distance from washers to drain: ______ Height of drain: _____
9. Steam available?: ____ Pressure?: ____
10. Ventilation for dryers: Numbers of vents: ______ Size of vents: _______
    Through roof?: ____ Work needed: ____
    Thickness of wall/ceiling for vent to go through: ______ Make-up air available? ______