

## APPENDIX E: FIXTURE AND APPLIANCE INFORMATION

- EPA WaterSense® High Efficiency Toilets
- Food Service Technology Center Low-Flow Pre-Rinse Spray Valves
- Alliance for Water Efficiency Introduction to Ice Machines
- Alliance for Water Efficiency Introduction to Coolers

## EPA WaterSense® High Efficiency Toilets

### Find a WaterSense® Labeled High-Efficiency Toilet\*

Last updated: 3/10/2009

**Please note:** Many high-efficiency toilets are sold in two parts, with the tank and bowl sold separately. When components combine to make a WaterSense labeled product, tanks should include the words "When used in combination with [bowl model number/name]" in close proximity to the label, and similarly with bowl labeling. Only the combinations listed below have been certified to bear the WaterSense label.



WaterSense retailers commit to making WaterSense products available in stores. However, products may not be available in all markets. For a complete list of WaterSense retail and distributor partners, please go to: <http://www.epa.gov/watersense/partners/partners.htm#retail>

Brand Name	Model Name	Model Number		
		HET	Tank	Bowl
American Standard	Cadet 3 FloWise Elongated Toilet	2832.128	4021.128	3014.128
American Standard	Cadet 3 FloWise Right Height Elongated Toilet	2835.128	4021.128	3016.128
American Standard	Cadet 3 FloWise Round Front Toilet	2829.128	4021.128	3011.128
American Standard	Cadet FloWise Pressure Assist EL Toilet	2462.100	4142.100	3481.100
American Standard	Cadet FloWise RH EL Pressure Assist Toilet	2467.100	4142.100	3483.100
American Standard	Cadet3 FloWise Compact EL One-piece Complete Toilet	2568.128		
American Standard	Cadet3 FloWise RH EL 12" Complete Toilet	3305.128	4021.128	3016.128
American Standard	FloWise	2073.014	4023	3018
American Standard	FloWise Cadet3 1-pc	2403.128		
American Standard	FloWise Dual Flush	2479.216	4035.216	3067.216
American Standard	FloWise Dual Flush Elongated Toilet, Lined Tank	2479.516	4035.516	3067.216
American Standard	FloWise Dual Flush Right Height Elongated Complete Toilet Lined Tank	2566.516	4035.516	3073.216
American Standard	FloWise Dual Flush Right Height Elongated Toilet	2480.216	4035.216	3073.216
American Standard	FloWise Dual Flush Right Height Elongated Toilet	2566.216	4035.216	3073.216
American Standard	FloWise Dual Flush Right Height Elongated Toilet Lined Tank	2480.516	4035.516	3073.216
American Standard	Mainstream FloWise RF Complete Toilet	3468.128	4061.428	3061.428
American Standard	NH EL Dual Flush Combo Toilet	2476.216	4035.216	3067.316
American Standard	NH EL Dual Flush Complete	2779.516	4035.516	3067.316

Brand Name	Model Name	Model Number		
		HET	Tank	Bowl
American Standard	NH EL Dual Flush Lined Combination	2476.516	4035.516	3067.316
American Standard	RH EL Dual Flush Combination	2484.216	4035.216	3073.316
American Standard	RH EL Dual Flush Complete	2778.516	4035.516	3073.316
American Standard	RH EL Dual Flush Lined, Combination	2484.516	4035.516	3073.316
American Standard	Yorkville FloWise PA Toilet	2876.100	4142.100	3701.100
American Standard	Yorkville FloWise RH PA Toilet	2878.100	4142.100	3703.100
Aquasenses	ES22114		ES3214	ES2214
AquaSource (a Lowe's brand)	AquaSource	005905		
Briggs	Conserver	4207	4484	4370
Briggs	Conserver	4208	4484	4375
Briggs	ProFlo		PF9212	PF9201
Briggs	ProFlo		PF9212	PF9200
Caroma	Adelaide 270 Cube		814790	834000
Caroma	Adelaide 270 Cube EH		814790	825500
Caroma	Adelaide 270 Standard		814328	834000
Caroma	Adelaide 270 Standard EH		814328	825500
Caroma	Bondi 270		726350	609159
Caroma	Bondi 270 EH		726350	607177
Caroma	Bondi 270 Elongated		726350	609100
Caroma	Bondi 270 Elongated EH		726350	609120
Caroma	Bondi 305		726350	609151
Caroma	Bondi 305 Elongated		726350	609130
Caroma	Brisbane 270		810266	833900
Caroma	Caravelle 270		629435	609159
Caroma	Caravelle 270 EH		629435	609177
Caroma	Caravelle 270 EH Elongated		629435	609120
Caroma	Caravelle 305		629435	609151
Caroma	Caravelle Elongated 270		629435	609100
Caroma	Caravelle Elongated 305		629435	609130
Caroma	Caravelle One Piece	989646		
Caroma	Caravelle One Piece EH	989668		
Caroma	Colonial 270		625070	605310
Caroma	Colonial 270 EH		625070	605320
Caroma	Profile Smart 305		840420W	609151A
Caroma	Royale 270		624530	609159
Caroma	Royale 270 EH		624530	609177
Caroma	Royale 270 EH Elongated		624530	609120
Caroma	Royale 270 Elongated		624530	609100
Caroma	Royale 305		624530	609151
Caroma	Royale 305 Elongated		624530	609130
Caroma	Sydney 270		622320	609159
Caroma	Sydney 270 EH		622320	609177
Caroma	Sydney 270 EH Elongated		622320	609120
Caroma	Sydney 270 Elongated		622320	609100
Caroma	Sydney 305		622320	609151A
Caroma	Sydney 305 Elongated		622320	609130

Brand Name	Model Name	Model Number		
		HET	Tank	Bowl
Caroma	Sydney Low Profile 270 EH		622330	609177
Caroma	Sydney Low Profile 270 EH Elongated		622330	609120
Caroma	Sydney Low Profile 270 Elongated		622330	609100
Caroma	Sydney Low Profile 270 Round		622330	609159
Caroma	Sydney Low Profile 305		622330	609151A
Caroma	Sydney Low Profile 305 Elongated		622330	609130
Caroma	Sydney Smart 270		622322	609159
Caroma	Sydney Smart 270 EH		622322	609177
Caroma	Sydney Smart 270 EH Elongated		622322	609120
Caroma	Sydney Smart 270 Elongated		622322	609100
Caroma	Sydney Smart 305		622322	609151A
Caroma	Sydney Smart 305 Elongated		622322	609130
Cascadian	Toscana		T901	C930
CEU		6810H	T-6810H	X-6810H
CEU		6810H-S	T-6810HS	X-6810HS
CEU		6811H	T-6811H	X-6811H
CEU		6811H-S	T-6810HS	X-6811HS
Crane	Eco Opus III	31692	31542	31562
Crane	Eco Opus III	31693	31543	31562
Crane	EcoGalaxy/Cranada	31007	31590	3352
Crane	EcoGalaxy/Cranada	31008	31590	3372
Crane	EcoGalaxy/Cranada	31067	31593	3352
Crane	EcoMiser	38370	31500	3827
Crane	EcoMiser	38400	31500	3830
Crane	EcoMiser BigFoot	38335	31500	31124
Crane	EcoMiser BigFoot	38345	31500	31125
Crane	EcoMiser BigFoot ADA	38355	31500	31128
Crane	Economiser One	31884	31612	31124
Crane	Economiser One BigFoot	31885	31612	31125
Crane	Economiser One BigFoot	31888	31612	31128
Crane	EcoSaratoga	31970	31960	3352
Crane	EcoSaratoga	31972	31964	3352
Crane	EcoSaratoga	31973	31964	3372
Crane	EcoSaratoga	31976	31966	3352
Crane	EcoSaratoga	31980	31960	3372
Crane	EcoSaratoga	31986	31966	3372
Duravit	2nd Floor Wall Hung Toilet		111.335	220509
Duravit	Caro Wall Hung Toilet		111.335	015609
Duravit	D-Code Two-Piece Toilet		092720	011701
Duravit	Darling Wall Hung Toilet		111.335	020709
Duravit	Foster Wall Hung Toilet		111.335	017509
Duravit	Happy D Two-Piece Toilet		091010	017009
Duravit	Happy D Wall Hung Toilet		111.335	017109
Duravit	Starck 2 Wall Hung Toilet		111.335	016009
Duravit	Starck 3 Two-Piece Toilet		092010	012809

Brand Name	Model Name	Model Number		
		HET	Tank	Bowl
Duravit	Starck 3 Wall Hung Toilet		111.335	220009
Duravit	Starck X Wall Hung Toilet		111.335	220409
Duravit	Vero Floor Standing Toilet		109.304	211709
Duravit	Vero Two-Piece Toilet		090910	211609
Duravit	Vero Wall Hung Toilet		111.335	221709
Foremost		TL-6100-EWN		
Foremost		TL-7600HC-HET-W	T-7600-HET-W	LL-7600HC-HET-W
Foremost		TL-7600HC-HET-WL	T-7600-HET-WL	LL-7600HC-HET-W
Foremost		TL-7600HC-HETR-W	T-7600-HET-W	LL-7600HC-HETR-W
Foremost		TL-7600HC-HETR-WL	T-7600-HET-WL	LL-7600HC-HETR-W
Foremost		TL-7700HC-HET-W	T-7700-HET-W	LL-7700HC-HET-W
Foremost	AIO	AIO1000-EW	Aiot1000-W	AIOB1000-EW
Foremost	AIO	AIO1000-RW	Aiot1000-W	AIOB1000-RW
Foremost	Plaza	TL-7107-WL	T-7107-WL	LL-7107-W
Foremost	Total	TT-2000E-WL	T-2000-WL	LL-2000E-W
Foremost	Total	TT-2010-WL	T-2010-WL	LL-2010-W
Gerber	Ultra Flush	DF-21-302	DF-28-380	21-342
Gerber	Ultra Flush	DF-21-304	DF-28-384	21-342
Gerber	Ultra Flush	DF-21-310	DF-28-380	21-374
Gerber	Ultra Flush	DF-21-312	DF-28-380	21-372
Gerber	Ultra Flush	DF-21-314	DF-28-384	21-372
Gerber	Ultra Flush	DF-21-318	DF-28-380	21-377
Gerber	Ultra Flush	DF-21-324	DF-28-384	21-377
Gerber	Ultra Flush	DF-21-325	DF-28-380	21-375
Gerber	Ultra Flush	EF-21-302	EF-28-380	21-342
Gerber	Ultra Flush	EF-21-304	EF-28-384	21-342
Gerber	Ultra Flush	EF-21-310	EF-28-380	21-374
Gerber	Ultra Flush	EF-21-312	EF-28-380	21-372
Gerber	Ultra Flush	EF-21-314	EF-28-384	21-372
Gerber	Ultra Flush	EF-21-318	EF-28-380	21-377
Gerber	Ultra Flush	EF-21-324	EF-28-380	21-375
Gerber	Ultra Flush	EF-21-325	EF-28-380	21-375
Glacier Bay (a Home Depot brand)		331-725 (BT6001)		
Glacier Bay (a Home Depot brand)	Elongated HET	331-725	N2225T	N2225EB
Glacier Bay (a Home Depot brand)	Round Front HET AIO	779-923	779-923T	779-923B
Greentide	GT 6810H		666-2	
Greentide	GT 6810H-S		666-1	
Greentide	GT 6811H		666-2	
Greentide	GT 6811H-S		666-1	
Jacuzzi	Espreo	EZ36959		
Kohler	Barrington	K-3652	K-4484	K-4327
Kohler	Cimarron	K-3609	K-4421	K-4309
Kohler	Cimarron EcoSmart	K-3496-HE	K-4634-HE	K-4286
Kohler	Escale	K-3588	K-4472	K-4308
Kohler	Fountainhead	K-3524		

Brand Name	Model Name	Model Number		
		HET	Tank	Bowl
Kohler	Highline Pressure Lite	K-3519	K-4484	K-4304
Kohler	Kelston	K-11453	K-4469	K-4306
Kohler	Persuade	K-3654	K-4419	K-4322
Kohler	Saile	K-3564		
Kohler	San Raphael Power Lite	K-3393		
Kohler	San Raphael Pressure Lite	K-3597		
Kohler	Wellworth Pressure Lite	K-3531	K-4484	K-4303
Mansfield	704 Prestigio	704		
Mansfield	EcoQuantum	144-119	119	144
Mansfield	EcoQuantum	146-119	119	146
Mansfield	EcoQuantum	147-119	119	147
Mansfield	EcoQuantum	148-119	119	148
Mansfield	EcoQuantum	149-119	119	149
Mansfield	Maverick 1.28	111-112	112	111
Mansfield	Quantum	144-153	153	144
Mansfield	QuantumOne	146-153	153	146
Mansfield	QuantumOne	147-153	153	147
Mansfield	QuantumOne	148-153	153	148
Mansfield	QuantumOne	149-153	153	149
Medyag	6810H			
Medyag	6810H-S			
Medyag	6811H			
Medyag	6811H-S			
Niagara	1.0 PA	N2310	N2310T	N2310B
Niagara	Cottage	N2228	N2228T	N2228B
Niagara	Eco-Logic		N2225EB	N2225T
Niagara	Eco-Logic		N2225RB	N2225T
OPS		T/X-6688	X-6688	T-6688
OPS		T/X-6688E	X-6688	T-6688E
OPS		T/X-6688H	X-6688	T-6688H
ORION	Green Sense EL		51299	50320
ORION	Green Sense RD		51299	50299
Pegasus (a Home Depot brand)	Cottage	840-565	N2228T	N2228B
ProFLO (a Ferguson brand)	HET Dual Flush ADA		PF9312	PF9303
ProFLO (a Ferguson brand)	HET Dual Flush EF		PF9312	PF9301
ProFLO (a Ferguson brand)	HET Dual Flush RF		PF9312	PF9300
ProFLO (a Ferguson brand)	HET Gravity Flush EF		PF9412	PF9401
ProFLO (a Ferguson brand)	HET Gravity Flush RF		PF9412	PF9400
ProFLO (a Ferguson brand)	HET Single Flush ADA		PF9412	PF9403
ProFLO (a Ferguson brand)	HET Single Flush EF		PF6112HE	PF6101HE
ProFLO (a Ferguson brand)	HET Single Flush EF		PF6212HE	PF6201HE
Quality Craft	Alexis HET	30013K	3003	3001
Quality Craft	Alexis HET Dual Flush	30014K	3004	3001
Seasons (a HD Supply brand)	Seasons		SE10039	SE10041
Seasons (a HD Supply brand)	Seasons		SE10039	SE10040
Seasons (a HD Supply brand)	Seasons	SE10042		
Sterling (a Kohler company)	Karsten EB	402028	402023	402026
Sterling (a Kohler company)	Karsten PB	402025	402023	402021
Sterling (a Kohler company)	Rockton EB	402027	402022	402026
Sterling (a Kohler company)	Rockton PB	402024	402022	402021
Sterling (a Kohler company)	Stanton	402040		
Swell	22114		3214	2214

Brand Name	Model Name	Model Number		
		HET	Tank	Bowl
Tangshan Ayers Bath	Dofiny HET		UAT1302-AA	UAC1301BS-AA
TOTO	Aquia	CST414M	ST413M	CT414
TOTO	Aquia II	CST416M	ST416M	CT416
TOTO	Aquia III	CST464M	ST464M	CT464
TOTO	Aquia IIIUH	CST464MF	ST464M	CT464F
TOTO	EcoClayton	CST784EF	ST784E	C784EF
TOTO	EcoDartmouth	CST754EF	ST753E	C754EF
TOTO	EcoDrake	CST743E	ST743E	C743E
TOTO	EcoDrake	CST744E(G)	ST743E	C744E
TOTO	EcoDrake	CST744EL	ST743E	C744EL
TOTO	EcoGuinevere	MS974224CE F(G)		
TOTO	EcoNexus	CST794EF	ST794E	CT794EF
TOTO	EcoPromenade	CST423EF	ST423E	C423EF
TOTO	EcoPromenade	CST424EF(G)	ST423E	C424EF(G)
TOTO	EcoSupreme	MS863113E		
TOTO	EcoSupreme	MS864114E		
TOTO	EcoUltramax	MS853113E		
TOTO	EcoUltramax	MS854114E		
TOTO	EcoUltramax	MS854114EL		
TOTO	EcoWhitney	CST754EFN	ST754E	C754EF
TOTO	Gwyneth	CST454CEF(G )	ST454E	C454CEF(G)
TOTO	Gwyneth	MS604114CE F(G)		
TOTO	Neorest 550	MS980CMG		
Tynan	Avoca	4344	1344	0344
Tynan	Cascade ADA	4354	1312	0354
Tynan	Cascade EF	4353	1312	0353
Tynan	Cascade RF	4352	1312	0352
Tynan	Foyle	4345	1345	0345
Tynan	MacLair	4347	1342	0347
Tynan	MacLair EF	4343	1342	0343
Tynan	MacLair RF	4342	1342	0342
Tynan	Nore	4346	1346	0346
Villeroy & Boch	AVEO		7724 U1 XX	6614 10 XX
Villeroy & Boch	Subway		7723 U1 XX	6610 10 XX
VitrA	Evergreen		5055	5076
VitrA	Evergreen		5066	5065
VitrA	Evergreen		5055	5074
VitrA	Evergreen		5402	5195
VitrA	Evergreen		5402	5196
Vortens	Dali	5928	5201	5101
Vortens	Delfos	3130	3130	3130
Vortens	Hurricane		3473	3140
Vortens	Hurricane EL		3473	3137
Vortens	Hurricane RF		3473	3213
Vortens	Loretto ADA		3475	3140
Vortens	Loretto EL		3475	3137
Vortens	Loretto RF		3475	3213
Vortens	Rhodas DF		3436	3123
Vortens	Tornado		3468	3138

Brand Name	Model Name	Model Number		
		HET	Tank	Bowl
Vortens	Tornado ADA		3468	3134
Vortens	Vienna ELX		3436	3113
Vortens	Vienna ELX		3420	3113
Vortens	Vienna RF		3420	3208
Vortens	Vienna RF		3436	3208
Vortens	Vienna Victory		3436	3209
Vortens	Vienna Victory		3420	3209
WaterRidge	360380 Two Piece Toilet	C21075C	C600137	C531082
WaterRidge	Grace Dual Flush One Piece Toilet	C22055C	C520093	C540552
Zurn	EcoVantage Dual Flush Round Front Toilet	Z5577	Z5562-TNK	Z5575-BWL
Zurn	EcoVantage Dual Flush, Elongated Toilet	Z5572	Z5562-TNK	Z5570-BWL
Zurn	EcoVantage Dual Flush, Elongated, ADA Toilet	Z5562	Z5562-TNK	Z5560-BWL
Zurn	EcoVantage Elongated ADA Toilet	Z5561	Z5561-TNK	Z5560-BWL
Zurn	EcoVantage Elongated Toilet	Z5571	Z5561-TNK	Z5570-BWL
Zurn	EcoVantage Round Front Toilet	Z5576	Z5561-TNK	Z5575-BWL

**\*Disclaimer of Endorsement:** Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government.



## Low-Flow Pre-Rinse Spray Valves



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A low-flow pre-rinse spray valve is one of the easiest and most cost effective energy saving devices available to the foodservice operator.

In addition to minimizing water consumption, water heating energy and sewer charges are also reduced. Replacing a typical spray valve that flows up to three gallons of water per minute (gpm) with a low-flow unit can yield the following results:

Hours of Spray Valve Usage	Water Savings gallons/day	Waste Water Savings gallons/day	Gas Savings therms/day	Annual Dollar Savings
1 hour/day	60 gallons	60 gallons	0.5 therms	\$300 - \$350
2 hours/day	120 gallons	120 gallons	1.0 therms	\$600 - \$700
3 hours/day	180 gallons	180 gallons	1.5 therms	\$900 - \$1050

Table shows results based on spray valve water savings of 1 gallon per minute, water cost of \$2.00 per unit (748 gallons), sewer cost of 3.00 per unit (748 gallons), and gas cost of \$1.00 per therm.

The FSTC recommends a pre-rinse spray valve with a flow rate of 1.6 gallons per minute or less, and with a cleanability performance of 26 seconds per plate or less, based on the ASTM *Standard Test Method for Performance of Pre-Rinse Spray Valves*.

The following pre-rinse spray valves have been verified by the FSTC to meet these criteria. Results of testing can be found at <http://www.fishnick.com/>.

- BK Resources PRV-1
- Bricor B064 PRV
- Bricor B074 PRV
- Bricor B084 PRV
- Bricor B094 PRV
- Bricor B095NS
- Encore KN50-Y002-12
- Fisher Ultra-Spray 2949
- Krowne Metal Water Saver 21-129
- Niagara N2180

- Strahman Kwik-Clean II
- T&S B-0107
- T&S B-0107-C
- T&S Equip 5SV
- T&S Equip 5SV-C
- T&S JetSpray B-0108
- T&S JetSpray B-0108-C
- T&S B-2108
- Zurn Z80000-PR1

The FSTC has supported the California Urban Water Conservation Council (CUWCC) to actively promote low-flow pre-rinse spray valves through its Rinse & Save program. Details of the program can be found on the CUWCC website.

The Federal Government has also issued guidelines for its facilities when purchasing pre-rinse spray valves. These guidelines, published by the Federal Energy Management Program (FEMP) can be followed by any facility interested in energy efficiency and conservation.

The FEMP pre-rinse spray valve recommendation is at <http://www.eere.energy.gov/femp/pdfs/prerinsenozzle.pdf>.

Also see the FSTC pre-rinse spray valve calculator at <http://www.fishnick.com/saveenergy/tools/watercost/>.



The Food Service Technology Center program is funded by California utility customers and administered by Pacific Gas and Electric Company under the auspices of the California Public Utility Commission.



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## Ice Machines Introduction

From Alliance for Water Efficiency (June 1, 2009)

[http://www.allianceforwaterefficiency.org/Ice\\_Machines.aspx](http://www.allianceforwaterefficiency.org/Ice_Machines.aspx)

Ice makers use more water than just the water contained in the ice. This equipment can often be very inefficient in water use. The typical icemaker uses 2 or 3 times more water than needed to make the ice we consume. These water using machines can be found everywhere; hospitals account for 39.4 percent of all commercial ice-maker purchases, followed by hotels (22.3 percent), restaurants (13.8 percent), retail outlets (8.5 percent), schools (8.5 percent), offices (4.3 percent) and grocery stores (3.2 percent).



There are two basic equipment designs: air-cooled refrigeration units and water cooled refrigeration units. The air-cooled units are usually more water efficient; while the water cooled units are usually more energy efficient. Both types vary greatly in water efficiency, even within its own design type. The water efficiency is measured by the industry in “gallons of water per 100 lbs of ice”. Perfect water efficiency would equate to 11.97 gallons of water to produce 100 lbs of ice. Most ice makers’ water use ranges between 18 to 200 gallons of water per 100 lbs of ice. This represents a water efficiency range of 66% to only 5%. Thus, 34% to 95% of the water used is dumped down the drain. The water varies for several reasons.

As the ice is formed in the freezing trays, minerals in the water collect in the equipment. These minerals must be occasionally rinsed off the freezing trays and the water reservoirs. Ice makers have a variable setting to initiate a rinse cycle at desired frequencies. The frequency of rinse is to be determined by local water quality and site requirements. Some new models actuate the rinse cycles based on sensor readings of minerals. Often the ice maker is set to rinse more often than necessary, resulting in water waste.

The “quality” of the ice can also affect water use. Some ice makers are designed to produce clearer and smoother ice by using a repeated freezing and partial thawing cycle while the ice is produced. This results in ice cubes that are smoother, without air bubbles and more crystalline like. Unfortunately, this aesthetic quality wastes a lot of water and serves no useful purpose; frosty ice cools just as well as clear ice.



Water cooled ice makers are often the most inefficient in water use, although sometimes providing significant energy savings at the point of use. It is important to note that there are many air-cooled ice machines **more** energy efficient than some water-cooled ice machines. Water cooled machines generally use potable water to remove heat from the refrigeration equipment. In years past, most of these machines used single-pass cooling – dumping the water into the sewer as it exited the machine. Fortunately, many manufacturers are started to abandon this wasteful design. Some newer designs re-circulate the water after it passes through a cooling tower or heat exchanger, but these still require large amounts of make up water. While air-cooled machines generally have a water efficiency of 40% to 66%, water cooled machines are usually less than 15% water efficient.

The water efficiency of most makes and models can be obtained by downloading “Certified Automatic Commercial Ice Makers Directory from the Air-conditioning and Refrigeration Institute” at [www.aridirectory.org](http://www.aridirectory.org).

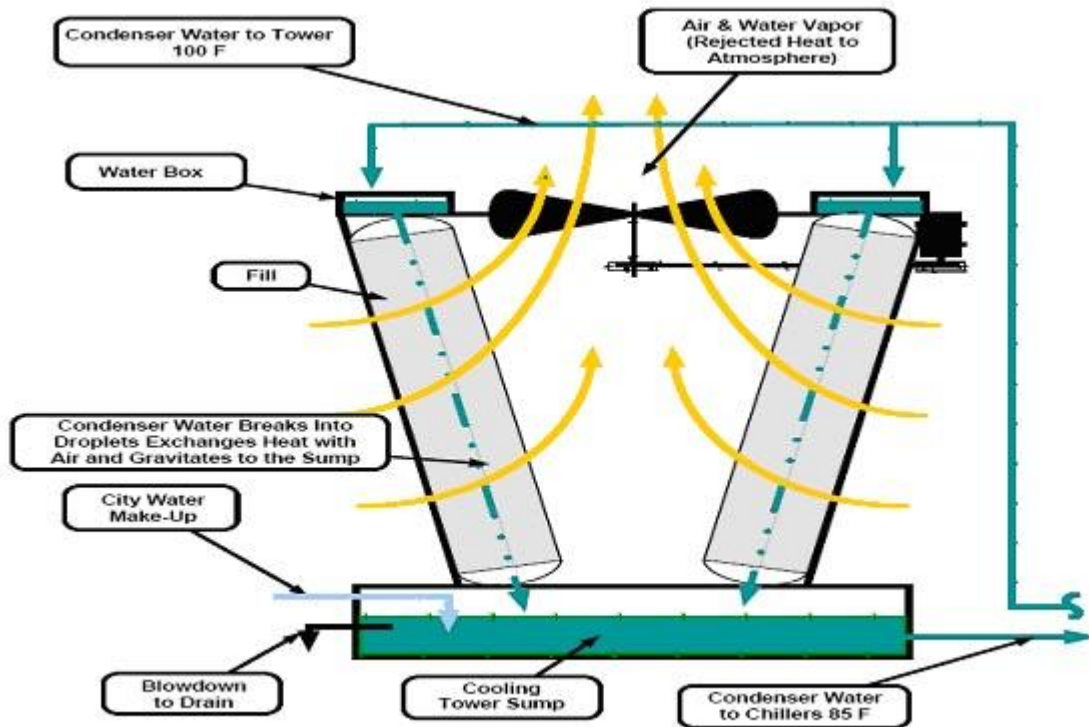
# Introduction to Cooling Towers

From Alliance for Water Efficiency (June 1, 2009)

[http://www.allianceforwaterefficiency.org/Ice\\_Machines.aspx](http://www.allianceforwaterefficiency.org/Ice_Machines.aspx)

Cooling towers are used in a variety of applications; from the 400 foot tall towers at nuclear power plants to small 4 foot cooling boxes used by neighborhood dry cleaners. The most common use is in large building central cooling systems, but also used for refrigeration, cold storage facilities, dry cleaning, medical equipment, manufacturing and industry. Cooling towers are generally the most efficient means to remove large amounts of heat from air and equipment. Unfortunately, cooling towers use large amounts of water when properly maintained, and can waste greater amounts of water when not maintained properly through wasteful practices, inefficient equipment and leaks.

Cooling systems transfer heat from one source or medium to another, often using water. In a cooling system with a cooling tower, cool water is pumped away from the cooling tower and is circulated through hot equipment (often chillers used to cool large buildings). The cool water (typically 85F) absorbs heat from the equipment and becomes warmer. The warmed water (typically 100 F) then returns back to the cooling tower. In the cooling tower the warmed water is sprayed downward, and air is blown upward with a fan. As the warm water droplets contact the air, some of the water droplets evaporate, and the air absorbs the heat released from this evaporation—thereby lowering the temperature of the remaining water. This cooling effect of the remaining water is called the latent heat of evaporation. During this process, some water is lost to the air from evaporation and some water is lost by the misting effect (called “drift”) into the air.



An outside source of water (usually from the local water utility), commonly referred to as “makeup water,” adds more water to the system to make up for evaporation and drift. Then, the water is re-circulated back to the heat exchanging equipment and the process is repeated.

Every water source has various levels of minerals, known as dissolved solids. When water evaporates from the system, these solids are left behind, causing the remaining water to become more concentrated in minerals. In order to maintain the same volume of water in the cooling system, more source water needs is added to the system. Again, this source water contains additional dissolved solids. Although the source water helps to somewhat dilute the concentration of minerals in the cooling system water, source water also contains some solids results in a net increase in concentration of solids in the system water. Therefore, as the system re-circulates the water in the cooling tower, some water evaporates leaving the minerals behind; the water’s impurities become more and more concentrated. As the system water increases in solids and minerals, the solids become more prone to attaching themselves to the pipe walls and other parts of the system. Concentrated solids can build up in the form of scale, causing blockages and corrosion to the cooling system materials. This scaling can cause catastrophic failure and damage to the system.

Most cooling towers purposefully remove some of the old water in the system and replace it with fresh water. To stay below this maximum acceptable concentration and to maintain the tower’s water balance, new water needs to be added to the cooling tower (called makeup water) and a portion of the concentrated cooling tower water needs to be discharged from the cooling tower (called blow-down or bleed). The amount of bleed needed depends on the system use and the quality of the fresh water supply. Often excessive bleed-off occurs due to improper adjustments made by the system operator.

Prescribed water levels must be maintained in the system to prevent catastrophic damage to the equipment; thus, automatic refill valves are installed to replace any water losses from evaporation, drift, bleed-off and leaks. Unfortunately, this allows leaks to often go unnoticed and continue for months or even years.

There are many measures that are needed to assure a cooling tower system is operating in a water efficient manner. At minimum the system should have: a) a dedicated water meter that is read daily by the local maintenance staff, and b) a TDS meter/controller to maintain proper bleed-off rates. In addition, acid treatment controllers and filtering equipment can greatly reduce water use while properly maintaining the equipment.