WATER USAGE

The following water usage table is calculated from test results during ETL EERa (capacity & efficiency test) certification and reported in accordance with CEC 400-2005-052 and its Appendix D.

Size Tons	Water Evaporated [1]	Condensate Recovered [2]	Flush Volume [3]	Water Tap H_2O/ Full Load Hour
2	3.24	0.66	0.82	3.40
2.5	4.06	0.83	1.03	4.26
3	4.87	0.99	1.23	5.11
3.5	5.68	1.16	1.44	5.96
4	6.49	1.32	1.64	6.81
5	8.11	1.65	2.05	8.51

1) 1.622 gallons/ ton hour calculated in accordance with Appendix D Equation 1.
2) We have used the 0.33 gallons/ ton hour Default Condensate Recovery from the CEC Appendix D. In humid climates the condensate from the indoor coil can reach 0.43 gph. **This water is required to be recovered - run to the unit sump for CEC Title 24 credit.**
3) Flush Volume in accordance with Appendix D Equation 2 - 0.41 gallons/ ton hour. Note: Flush is non-consumptive (regarding Air Conditioning) usage of water – water is returned to sewer or used for vegetation.

By using the ARI "Full Load Equivalent Hours Chart" to determine the run hours for a given location, then multiplying that number times the Site Net H_2O / Full Load Hour (water evaporated – condensate recovered + flush) above, you can estimate the annual residential water obtained from the water tap (site only – w/o powerplant savings), in order to calculate site water charges.

The water Consumption for water utility purposes is calculated by using the Site Net H_2O / Full Load Hour, adding back the Flush Volume, and the power plant water savings; then multiplying that number times the ARI Full Load Hours. The Flush is either used for vegetation (vegetation usage) or returned to the sewer system for reuse and therefore is not a part of the air conditioning consumptive use.

Size Tons	Water Tap H_2O/ Full Load Hour	Flush Volume [3]	Kwh H2O saved [4]	Net H_2O / Full Load Hour
2	3.40	0.82	2.12	0.46
2.5	4.26	1.03	2.65	0.58
3	5.11	1.23	3.18	0.70
3.5	5.96	1.44	3.71	0.81
4	6.81	1.64	4.24	0.93
5	8.51	2.05	5.30	1.16

4) According to the National Renewable Energy Laboratory (NREL/TP-550-33905), Electric power generation evaporates water at a rate per kWh of: 1) Arizona 7.85 gallons/ kWh, 2) California 4.64 gallons/ kWh, 3) Nevada 7.25 gallons/ kWh. We have used the NREL weighted national average of 2 gallons per kWh for the above table. At 2 gallons/Kwh & .53 kWh saved per ton/hour – based on 15 EER vs 10 SEER/9EER @ 95F; the net water saved is ~1.06 gal/ ton hour.

Example 1: Homeowner Water Bill Consumption:

- 3 Tons cooling = 5.11 gph (Water Tap H_2O/ Full Load Hour)
- For 1,400 annual equivalent full load cooling hours, 5.11 gph x 1,400 hours = 7,154 gallons per year.
- 748 gallons = 100 ft^3 = 1 CCF. Therefore, annual consumption = 7,154/748 = 9.6 CCF. At a rate of $1.05/CCF, cost of water consumption = $10.08/year.

Utility Incremental Water Consumption:

- 3 Tons cooling = 0.70 gph Net H_2O / Full Load Hour
- For 1,400 annual equivalent full load cooling hours, 0.70 gph x 1,400 hours = 980 gallons per year – community impact.

MINERAL CONCENTRATION FORMULA & EXAMPLES

As water evaporates, the minerals are left behind. The volume of minerals depends on:

- the size of the unit (in BTU/hr)
- the number of operating hours
- quality of water supply

The relative mineral concentration at any point prior to flushing is expressed by the following formula:

$$= \frac{\text{Evaporation}}{\text{Flush + Sump Capacity}}$$

- **Example 1: No Flush System (example only - not an available option)**

3 Ton water evaporation = 4.87 gph
condensate recovery = 0.99 gph
net water consumption = 3.88 gph
Annual consumption = 3.88 gph x 1,400 hours = 5,432 gallons.
Concentration = 5,432 gallons/~10 gallons in sump = 543.
Assume the water is at the drinking water maximum of 1,000 ppm. A concentration of 543 times will result in 543,000 ppm. This would be 54.3% solids (543,000 / 1,000,000), or 5.4 gallons of solid minerals. Thus, the minerals would become so thick that there would be deposition of minerals (mainly white crusty deposits of calcium carbonate).

Note: As a general comparison, sea water may be 20,000 – 25,000 parts/million (ppm).

- **Example 2: Flush System**

With flush of the sump every 8 hours of run time, evaporation of 4.87 gallons per hour, 1,400 hours operation, 0.99 condensate recovery, = 3.88 gallons / hour. With flushes every 6 hours the concentration is from fresh water (assume city water at 1,000 ppm) to 6 hours concentration or a maximum of 2.328 concentrations (3.88.hour x 6 hours /10 gallon sump). This would be 0.23% solids (2,328 / 1,000,000), or 0.23 gallons (~.36 of a cup) of solid minerals. Thus, there will probably not be substantial deposition of minerals. (Note: condensate is generally presumed to have no minerals).

WATER CONSERVATION

FREUS™ units are qualified as water saving devices in water conservation areas because:

- FREUS™ units recirculate water. As an example, a nominal 3 Ton unit with a combined water usage of 5.11 gph will recirculate over 900 gph. That is a reuse factor of 176 to 1 (900 divided by 5.11).
- FREUS™ units generally have much lower water consumption than the allowed amount in areas that have absolute water consumption standards.
- For example, Fresno, California, Section 14-201 limits evaporative condenser consumption to 9 gph (code 0.15 gpm x 60 minutes) per ton of capacity. A 3 Ton unit offers an 84% savings versus this limit by using 1.7 gph per ton (5.11/3 = 1.7) verses the allowed 9 gph/ ton which is ~5.3 times more water use).
- Bakersfield 14.12.220,B.23. Prohibits blowdown/ bleed greater than 1/3 (33%) of the total make up water being discharged to the sewer. Flush discharge to vegetation is preferred, so that the water is used at the site, instead of being processed for use downstream. On a three ton Freus with total make up water (evaporation) of 4.87 gallons per full load hour has a blowdown (flush) of just 1.23 gph or 25% of the make up water, and is 24% better than the code requires.

A FREUS™ unit is designed to be a water conservation device. The above factors are the reasons FREUS™ units are approved in water restrictive areas.

WATER TREATMENT

In areas with very high mineral content magnetic water treatment has proven effective. Chemical water treatment is limited to food grade hexametaphosphate (Nu-Calgon Micromet). This plus city water treatments (Chlorine and etc.) are generally an adequate biocide treatment in proper proportion for residential applications.

Periodic flushing is provided to control mineral deposits. With city treated water, the flushing brings in additional biocides (i.e. chlorine) contained in the city water. The water pan is shaded by the intake grill assembly to restrict the growth of algae.

If an owner determines additional chemical water treatment will be used, the FREUS™ warranty will not be affected by any chemicals approved by the Cooling Tower Institute for use on evaporative condensers with copper tubes. Check local codes and water authorities for permissible disposal of chemically treated water.

Note: Avoid adding chlorine! Adding just 1/8 cup of chlorine bleach to the sump may cause chlorine shock and corrosion problems.

Flush System Discharge

Optimal water conservation is provided by discharging the flush to vegetation. The water is preferably distributed to a drip irrigation system and used as part of the water make up in a total irrigation system. If water is discharged to the sanitary (sewer) system then the following table can serve as a guideline to the quantity of water to be discharged. The water volume discharges should never be more than 1/3 of the total make up water.

Note: When adding chemicals, Route the flush in accordance with applicable water disposal codes.

							Moderate Water Hardness			High Water Hardness		
									Unrestricted			Unrestricted
Size Tons	Water Evaporated[1]	Condensate Recovered[2]	Net Make Up Water / hour	Net Make Up Water in 6 or 3 hours	Max Flush Rate @ 50% of Gross[3]	Flush Hose Size	Hours / Min	Concentration	Flush Gal.	Hours / Min	Concentration	Flush Gal.
1.50	2.43	0.50	1.94	11.63	7.30	3/8"	6 / 6	1.66	7	6 / 6	1.66	7
2.00	3.24	0.66	2.58	15.50	9.73	3/8"	6 / 6	2.21	7	6 / 6	2.21	7
2.50	4.06	0.83	3.23	19.38	12.17	3/8"	6 / 6	2.77	7	3 / 6	1.38	7
3.00	4.87	0.99	3.88	23.26	14.60	3/8"	6 / 6	3.32	7	3 / 6	1.66	7
3.50	5.68	1.16	4.52	13.57	8.52	3/8"	3 / 6	1.94	7	3 / 9	1.36	10
4.00	6.49	1.32	5.17	15.50	9.73	3/8"	3 / 6	2.21	7	3 / 9	1.55	10
5.00	8.11	1.65	6.46	19.38	12.17	3/8"	3 / 6	2.77	7	3 / 9	1.94	10
6.00	9.73	1.98	7.75	23.26	14.60	1/2"	3 / 6	1.94	12	3 / 9	1.37	17
7.00	11.35	2.31	9.04	27.13	17.03	1/2"	3 / 6	2.26	12	3 / 9	1.60	17
8.00	12.98	2.64	10.34	31.01	19.46	1/2"	3 / 6	2.58	12	3 / 9	1.82	17
9.00	14.60	2.97	11.63	34.88	21.90	1/2"	3 / 6	2.91	12	3 / 9	2.05	17
10.00	16.22	3.30	12.92	38.76	24.33	1/2"	3 / 6	3.23	12	3 / 9	2.28	17

[1] 1.622 gallons per ton hour

[2] 0.33 gallons per ton

[3] Bakersfield Regulation - 50% of gross evaporated is 33% Max of total make up water

[4] Gallons of water per flush

Water Quality

In applications with very severe water quality issues, there are several methods to handle the water quality levels,

A). Water Treatment

1. Magnesium cathodic treatment - is included with the unit – be sure the anode has not been consumed and replace it if necessary.
2. Chemical water treatment is limited to food grade hexametaphosphate (Nu-Calgon Micromet).
3. Magnetic water treatment – can be added on the make up water. There are several sources, please call Freus Technical Assistance for recommendations. Magnetic treatment has proven effective for scale, but not other water quality issues.
4. Other Chemical Water Treatment – check with local water treatment companies.

B) Increased Flushing

1. Increased Flush rates (more frequent flushing timer)
2. Add bleed off to the recirculating water line

C) More Frequent Maintenance – schedule as shown by local experience.

Central Water System

For systems with a central water system the individual Freus units can be plumbed to a central system and traditional water control systems can be employed. Central systems can also be used for freeze protection designs on commercial applications.