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COMMISSION

ADVANCED EVAPORATIVE COOLING WHITE PAPER

TECHNICAL REPORT

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Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Commission), annually awards up to $62 million to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following six RD&D program areas:

- Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy
- Environmentally-Preferred Advanced Generation
- Energy-Related Environmental Research
- Energy Systems Integration

What follows is an attachment to the final report for the Development of an Advanced Indirect Evaporative Heat Exchange Module project, Contract Number 500-98-022, conducted by Davis Energy Group. This project contributes to the PIER Building End-Use Energy Efficiency program.

This attachment, "Advanced Evaporative Cooling" (Attachment 1), provides supplemental information to the project's final report.

For more information on the PIER Program, please visit the Commission's Web site at: http://www.energy.ca.gov/research/index.html or contact the Commission's Publications Unit at 916-654-5200.

Abstract

This "Advanced Evaporative Cooling" attachment is supplemental information to the Development of an Advanced Indirect Evaporative Heat Exchange Module project, funded by the California Energy Commission's Public Interest Energy Research (PIER) Program.

Davis Energy Group has developed a "Generation 3" indirect-direct evaporative cooler (IDEC) with support from the California Energy Commission's PIER program. The unit combines advances in airflow configuration with manufacturing improvements to reduce costs and improve efficiency and reliability. Full year performance simulations based on test data indicate 89 to 95% IDEC annual energy savings and 80 to 89% peak demand reduction for typical California applications.

This attachment, "Advanced Evaporative Cooling" (Attachment A-1), provides an excellent overview of evaporative cooling technology and markets produced by Davis Energy Group in 2002.

Advanced Evaporative Cooling White Paper

1. Overview of Evaporative Cooling Principles

Evaporative cooling occurs when moisture is added to air that has a relative humidity of less than 100%. The lower the relative humidity, which is dependent on the air's dry and wetbulb temperatures, the greater the potential for evaporative cooling. The cooling sensation felt by a person when a breeze passes over and evaporates perspiration on their skin, is doubtless the most common human experience with the phenomenon. Using an electric fan to cool air by forcing it through wetted media, as occurs in modern direct evaporative coolers, is an obvious extension of this concept.

Drybulb temperatures, widely reported values measured with typical mercury-bulb thermometers, impact evaporative potential. The greater the difference between dry and wetbulb temperatures ("wetbulb depression"), the greater the temperature drop achievable in an evaporative process. During a hot California valley summer day, for example, with drybulb and wetbulb temperatures of 105° and 65°F respectively, a 75% effective direct evaporative cooler would deliver 75°F air.

1.1 Principles of Operation, Single and Two-Stage Equipment

Direct (single-stage) evaporative cooler (Figure 1) designs generally combine a metal or plastic cabinet housing a sump (reservoir), evaporative media, re-circulation pump, float switch, fan, and distribution piping generally configured as illustrated in figure 1-1.

In direct cooler operation, a water-filled reservoir ("sump") is maintained in the lower portion of a cabinet by a float valve or switch controlling the flow of city water from a connection to the household plumbing. As the water level in the sump falls due to evaporation, the fill valve opens until the sump is refilled. While the cooler operates, sump water is circulated by a pump through a distribution system over the evaporative media to keep it evenly wetted. A supply fan pulls outdoor air through the wetted media, cooling and humidifying the air.

Direct coolers are the simplest and lowest first cost approach to evaporative cooling. Direct cooling contributes the maximum moisture fraction to supply air, producing a different quality of cooling than vapor compression systems that tend to dehumidify, even under dry indoor conditions. Direct coolers are most likely to produce high indoor humidity conditions under high cooling loads (perhaps the most common complaint associated with evaporative cooling). The drier the ambient air and the lower the cooling load, the more likely a direct system can provide acceptable indoor cooling comfort. As outdoor wetbulb temperatures rise, supply air temperatures rise.

Common single-stage mounting options include ducted through a wall or window (as shown), and on the roof with supply air ducted down through the roof. Open windows may substitute for barometric relief dampers shown, but in either case, unrestricted exhaust of supply air is an essential ingredient of effective evaporative cooling. 100% outdoor air flow improves indoor air quality, and relief dampers lower attic temperatures, reducing indoor cooling loads and improving overall system performance.

Figure 1:

Direct (single-stage) Evaporative Cooler (DEC)

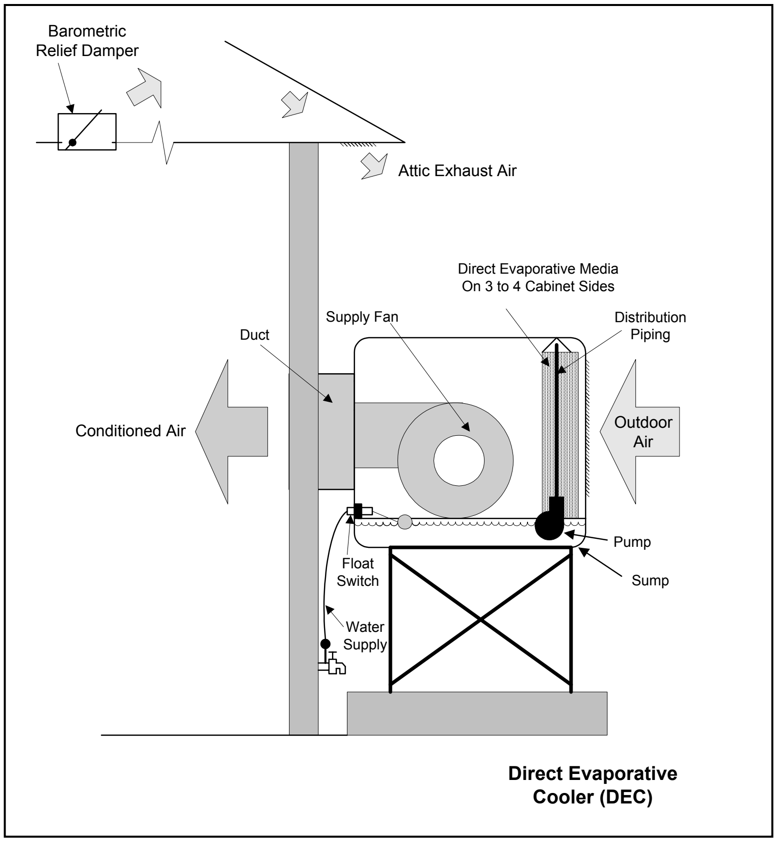
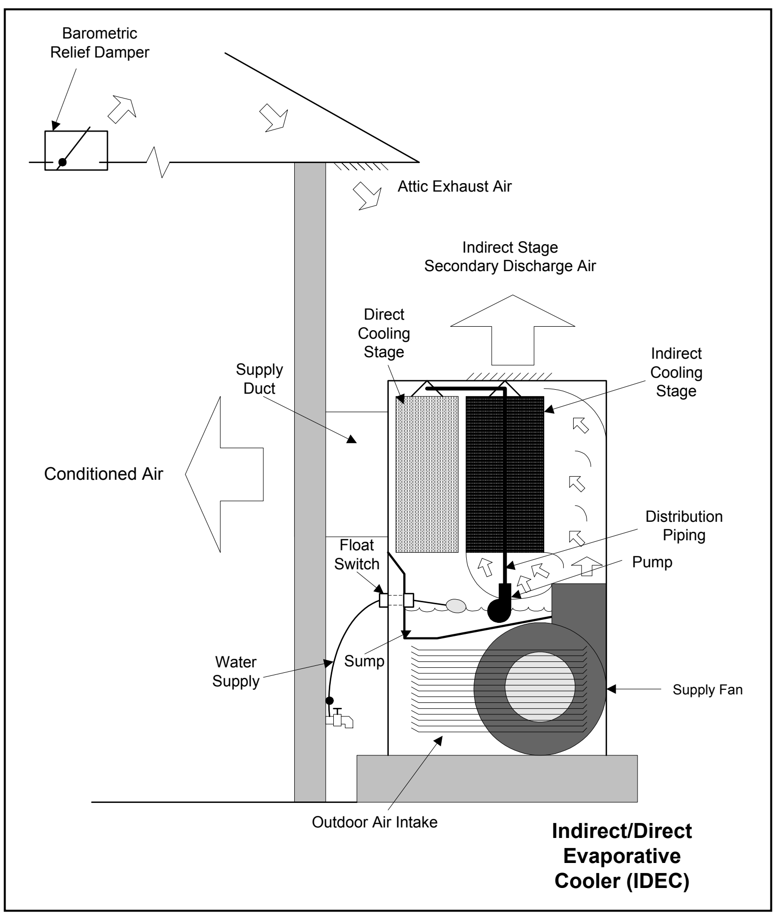


Figure 2:

Indirect/Direct (two-stage) Evaporative Cooler (IDEC)



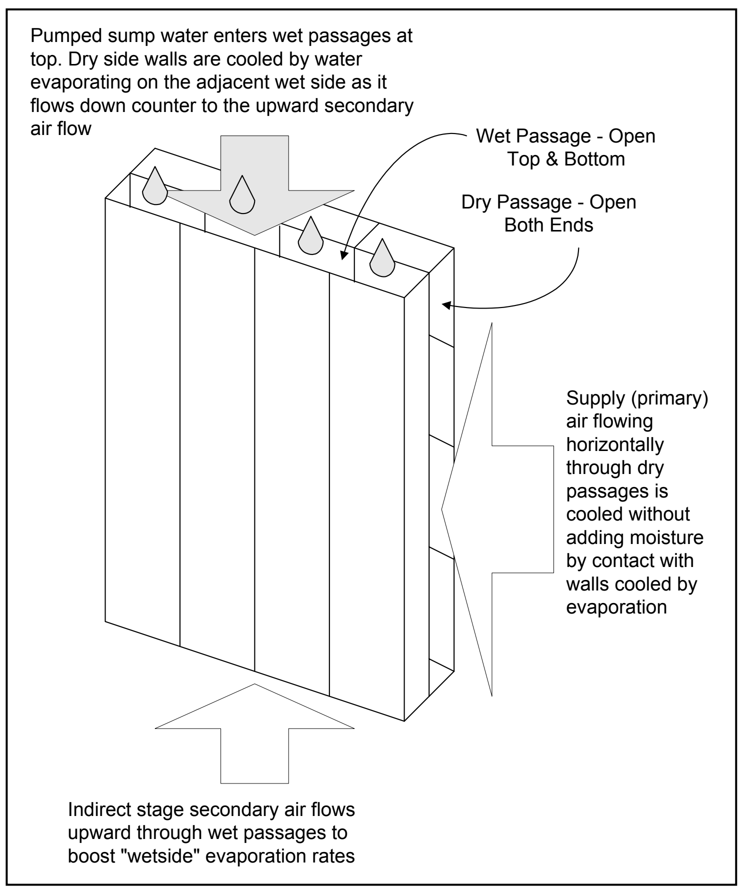
Indirect/Direct (two-stage) evaporative cooler (Figure 2) designs add an indirect evaporative heat exchanger upstream of the direct stage. The indirect stage cools the outdoor air without adding moisture. Depending on conditions, the direct stage can further cool air to below the wetbulb temperature. The result is cooler and drier supply air than can be achieved with a single-stage cooler. Residential designs using indirect-only heat exchangers only tend to be too large and costly for feasible application.

Different cabinet and component configurations may be used to accomplish two-stage cooling. The only production unit currently on the market “piggy-backs” a separate indirect module with separate sump, pump and fan, onto a direct evaporative coolier. The unit shown in Figure 2, is the “IDEC” system developed and demonstrated in the mid ‘90’s under a CEC Energy Technology Advancement Program (ETAP) contract. IDEC prototypes, featuring a single sump, pump, small footprint and high efficiency variable speed motor, were extensively tested and monitored under the CEC program and subsequently through a Pacific Gas & Electric Company (PG&E) R&D project over a period of nearly 5 years. Most of the available monitored performance data for 2-stage units were obtained at IDEC test and demonstration sites.

In the IDEC design, outdoor air is drawn in at the bottom of the unit and directed vertically into the primary and secondary paths. Supply (primary) air is turned horizontally by vanes in the air path to enter the plastic indirect stage where it passes through horizontal dry passages alternating with vertical wet passages (Figure 3). Evaporation cools the walls of the wet passages, which in turn precools the air in contact with the dry side as it flows through to the direct stage.

Figure 3:

Indirect Evaporative Heat Exchanger



2. Evaporative Cooling Market Assessment

The market for cooling and heating equipment in the United States is large, approaching $20 billion per year. In contrast, the U.S. market for evaporative cooling equipment is very small, perhaps 1% to 2% of the total. Since the industry is so small, detailed reliable information about the industry is difficult to obtain. For this this report, numerous sources and publications were reviewed, including:

- Air Conditioning, Heating and Refrigeration News
- Air Conditioning and Refrigeration Institute
- American Council for an Energy Efficient Economy (ACEEE)
- American Society of Heating, Air Conditioning & Refrigeration Engineers (ASHRAE)
- California Energy Commission
- E Source
- Evaporative Cooling Institute
- National Renewable Energy Laboratory
- Private Companies (Munters, Champion)
- US Department of Energy – Energy Information Administration
- US Census Bureau
- Davis Energy Group, Professional Experience

Despite apparently abundant information sources, the data actually obtainable are not detailed. This reflects the small nature of the industry, the fact that the manufacturers are privately held companies or modest divisions of much larger companies, and the lack of a well financed industry association.

2.1 Market Size and Characterization

Evaporative equipment market. According to the US Census Bureau 1997 Economic Census, the market for evaporative air coolers totaled $191.6 million in 1997, up 19% from $161.6 million in 1992. These numbers include both the residential and commercial markets. The size of the market was confirmed by Robert Foster, Director of the Evaporative Cooling Institute, a small, part-time industry association. According to Foster, the market totals about $180 million in annual sales. According to E Source, evaporative cooling is used to cool 3% to 5% of floor space in commercial buildings constructed in the United States. Evaporative cooling equipment market share is slowly growing in the commercial market as desiccant dehumidification systems are being incorporated, expanding their geographical market. Uninstalled costs of selected evaporative cooling equipment types are estimated as follows (*Commercial Space Cooling & Air Handling Technology Atlas*, G. Cler, M. Shepard et al, 1997, E Source):

TABLE 1: **Equipment Classes**	**$/cfm**
Residential evaporative cooler	0.10 – 0.20
Commercial-scale single-stage direct evaporative cooler (rigid media module with pump, piping, stainless steel housing and sump, without fan)	0.20 – 0.50
Commercial-scale indirect (polymeric heat exchanger, scavenger fan, stainless steel housing and sump pump, piping, automatic draw-down-fill, freezstat, without supply fan)	0.75 – 0.95
Commercial-scale indirect-direct (polymeric heat exchanger, scavenger fan, stainless steel housing and sump pump, piping, automatic draw-down-fill, freezstat, without supply fan)	1.10 – 1.40

One of the reasons the commercial market for evaporative cooling equipment is small is that the systems require a more costly customized design effort than conventional vapor compressions systems. The equipment is often custom built and does not enjoy the large economies of scale enjoyed by vapor compression equipment. Consequently, even though evaporative cooling equipment has fewer moving parts and is inherently simpler than vapor compression equipment, it may nevertheless be more expensive.

In contrast to the commercial market, the residential market is characterized by standardized, mass produced direct evaporative coolers. These machines have very low initial costs and operating costs and are typically found in manufactured housing and other low-end markets. Despite cost advantages, they are hard-pressed to compete against conventional air conditioning equipment. In a recent interview, Joe Hamon, Vice President of Sales and Marketing for the Champion Cooler Corporation said, "the only 'growth' being experienced in the market is one firm stealing sales from another". The first costs of volume-produced refrigeration cooling equipment are so low that it is increasingly difficult for evaporative coolers to compete. Operating efficiencies of vapor compression equipment have also trended up, while electricity costs have been relatively stable in real terms, making the operation of vapor compression equipment affordable in most markets. Finally, in many climates, the dehumidification provided by vapor compression equipment is essential to maintain indoor comfort.

Evaporative Cooling Marketing Channels. The spectrum of "evaporative cooling" products includes a broad range of systems and components as varied as roof spray cooling systems, outdoor mist systems, evaporative intake air pre-coolers for large vapor-compression packaged air conditioners, specialty engineered system components, and many others. However, the focus of this report is evaporative cooling products that compete in traditional residential markets for unitary space cooling equipment. This section identifies traditional distribution means for packaged residential, and commercial/industrial packaged and custom, direct, indirect and indirect/direct evaporative space cooling products. The dominant distribution channels for these products are (1) direct marketing, (2) hardware retailers, (3) HVAC contractors and (4) HVAC equipment distributors or wholesalers.

Specific market segments served by each of the four dominant channels are shown in the table below. "X" marks indicate distribution channels listed horizontally across the top of the table, serving corresponding market segments listed vertically in the left-hand column.

TABLE 2: Market Segments	**Direct Marketing(1)**	**Hardware Retailers(2)**	**HVAC Contractors(3)**	**HVAC Distributors(4)**
Residential				
Direct	**X**	**X**	**X**	**X**
Indirect(5)				
Indirect/direct	**X**	**X**	**X**	**X**
Commercial/Industrial				
Packaged direct, indirect, indirect/direct	**X**		**X**	
Custom direct, indirect, indirect/direct	**X**		**X**	

Notes:

(1) Factory-direct and "reps" calling on architects and engineers; residential product wholesalers and retailers.

(2) Neighborhood store to "big box", and catalog retailers (eg, Graingers).

(3) "Dealer networks". Many small HVAC contractors offer one or more evaporative cooler lines. Large design-build mechanical contractors specify commercial/industrial class equipment for specific applications.

(4) Most HVAC equipment distributors offer several evaporative cooler lines.

(5) There are no known residential-scale indirect products in distribution.

Direct and indirect/direct residential products are marketed through all four-distribution channels. Manufacturers sell factory-direct or through manufacturers' representatives to:

1. Small and large hardware retailers including catalog outlets;
2. HVAC contractors responding to demand for a lower-cost alternative to vapor compression cooling products ("dealers"), and
3. HVAC equipment distributors/wholesalers. Geographically, residential units are almost exclusively distributed in dry western valley and southwest desert climates.

Packaged and custom commercial/industrial (C/I) products of all configurations are marketed primarily by manufacturers' representatives calling on architects, engineers and mechanical contractors. C/I equipment distribution appears significantly less climate-sensitive than residential.

Manufacturers' representatives ("reps") are a potent distribution force in many US manufacturing sectors, and particularly in HVAC and related equipment, including evaporative cooling. Their employment for the introduction of (properly positioned) new products can be especially favorable considering their ability to achieve short-term high-volume distribution at minimal direct costs because they typically work on sales percentage commissions.

The table below identifies manufacturers' reps handling evaporative cooling products in California and other western markets, according to the latest information released by the California Energy Commission*.

TABLE 3:

Firm (State)	Phone	Firm (State)	Phone
Conservation Mechanical (CA)	(707) 829-2080	Mega Corporation (ID)	(208) 523-7720
Conservation Mechanical (CA)	(916) 852-8088	Mullan Sales & Marketing (BC)	(604) 656-9357
Conservation Mechanical (NV)	(702) 322-3422	Wright Equipment Co. (CA)	(916) 381-6666
Duckworth Environmental (CA)	(209) 449-8701	R&R Enterprises (SD)	(605) 347-4556
Haldiman & NGE (CA)	(213)726-7011	Robert E. Jones Co. (CA)	(916) 663-4000
Harlan Mechanical Sys (CA)	(209) 435-6256	Tempco Equipment (CA)	(916) 736-2888
Knutson & Associates (CA)	(619) 251-6893	Wayne Harris Company (TX)	(214) 385-8068
March Equipment (CA)	(916) 381-8808	Westates Pacific Co. (CA)	(415) 948-9694
Marketing Associates (AZ)	(602) 942-1155	WR & Associates (CA)	(510) 534-8700
McClintock & Busted (CA)	(818) 893-4609		

Key:
(CA) – California (AZ) – Arizona (BC) – British Columbia (TX) - Texas
(NV) – Nevada (ID) -- Idaho (SD) – South Dakota
CEC Consumer Guide, Vol. 3, March 1995

Evaporative Cooling Equipment Manufacturers. Identifying manufacturers of evaporative cooling products competing in the unitary space cooling market is difficult because the few available industry information sources tend not to differentiate between space cooling-targeted companies and the many other companies serving myriad other specialty markets which are not directly competitive.

A national survey of manufacturers conducted by E Source in 1998 has produced the most recent, complete and accurate compilation of manufacturers of evaporative space cooling equipment. The tables in Appendix A updates the E Source list and identifies individual manufacturers with contact information and the types and size ranges of equipment they manufacture. Forty-one companies are identified which collectively produce packaged and custom direct, indirect, and indirect/direct equipment ranging from 1,000 to 1,000,000 cfm per unit. Only four of the forty-one firms listed manufacture residential as well as commercial/ industrial equipment. Three of the four residential manufacturers are headquartered in Arizona.

Vapor Compression Equipment. The U.S. Department of Commerce estimates that the market for air conditioning and heating equipment totaled $18.6 billion in 1995. It also estimates that 22 million tons of capacity were shipped in 1994 with about 8 million tons destined for the commercial market. These numbers dwarf those for evaporative cooling equipment. The Air Conditioning & Refrigeration Institute (ARI) estimates the number of units shipped as follows:

TABLE 4: Equipment Class	1994	1995 (000 Units)	1996	1997
Unitary Systems - Including Heat Pumps	4,900	5,090	5,670	5,360
Air-to-Air Heat Pumps	1,008	1,025	1,148	1,131
Reciprocating Chillers	12	14	14	14
Absorption Chillers	.5	.5	.6	.4

According to the Department of Energy Information Administration (EIA) by 1993, 72% of U.S. homes had some form of air conditioning, with nearly 50% saturation for central systems. Window units are found in 25% of the nation's 97 million housing units. Evaporative coolers are found in only about 3% of the nation's houses, according to this source. This percentage is higher in the dry western states, however. In 1996, the California Energy Commission estimated that evaporative coolers were used in about 8% of California homes and 37% of California mobile homes. In new production housing, even "starter homes" are typically equipped with central air conditioning systems. In short, vapor compression air conditioning systems have grown to command the residential space cooling market.

2.2 California Evaporative Cooling Potential

Commercial markets. Technically, the potential market for evaporative cooling in the western U.S. is very large. Significant penetration of some California commercial markets has been achieved. Chain building supply retailer Home Depot uses evaporative cooling in many of its California stores and reports an improvement in load factors from 55% to 70% as a result. Home Depot concludes evaporative cooling can be applied effectively wherever the wetbulb temperature remains below 70^{o} F. Many commercial applications employing auxiliary evaporative cooling components can achieve simple paybacks from energy savings in 2 to 6 years, and driven by such economics should gain increasing market share.

Residential markets. Direct evaporative coolers may be expected to hold their own serving small niche markets principally in desert climates. Lower product quality, comfort, shorter equipment life, and higher maintenance requirement perceptions must be expected to continue to inhibit significant market growth.

Recent studies and field demonstrations of indirect/direct (2-stage) units indicates far greater potential for such "advanced" systems. Field monitoring shows they work best in dry climates and low to moderate load applications, typical of many if not most California markets. Under average Central Valley cooling conditions (60°-70°F wetbulb) for example, advanced evaporative coolers are able to supply air at temperatures between 60° to 70°F, only 10° to 15°F warmer than vapor compression systems, with average supply air relative humidity below 70%. Cooling efficiency levels (Btu/Watt-hour), 100% to 300% higher than 10-SEER air conditioners have been measured under such conditions. Projected demand savings based on measured efficiency are 70% or more, relative to conventional air conditioners.

Of the handful of residential cooler manufacturers, only AdobeAir of Phoenix, AZ, offers an indirect/direct product. Marketed under the "MasterCool 2-Stage" label, it is an "indirect cooling module (ICM)" designed for installation in combination with any MasterCool brand direct cooler (*www.adobeair.com*, copyright 2000 Adobe Air, December 2001). Mastercool units have been the subject of recent (1993) field monitoring and performance analysis (Section 4).

Most advanced system monitoring data and analysis have been obtained through the CEC ETAP funded development, demonstration, and subsequent testing of the "IDEC" Indirect/Direct Evaporative Cooler prototypes, at four valley and two desert sites in 1994 and 1995.

Hoping to build on the highly favorable IDEC prototype results, a Sacramento-based group formed a venture to license and manufacture the IDEC product. Dubbed IDAC for Indirect/Direct Air Conditioner, the production version included several major design compromises, which proved over time to render the unit marginally viable, compared to the prototypes. After producing and installing several hundred units aided by utility incentives, the IDAC venture was dissolved. Monitored performance data for IDEC and IDAC as well as MasterCool are provided in Section 4.

Davis Enenrgy Group cooperated in the IDAC venture recognizing design compromises might have some limiting affect on system performance, but not knowing they would prove fatal. Seeking long-term resolution of the major failing at the outset, DEG applied for and in 1999 was awarded a CEC PIER contract for development of an improved indirect heat exchange stage. That project is in its final stage and is scheduled to conclude in the third quarter of 2002. The project goal is to produce a design equal to or better than the 1994 prototypes, and attract a viable manufacturer to bring it to market.

3. Current Title 24 Status

Under the present Standards, direct or indirect/direct evaporative coolers may be used with any compliance approach subject to the eligibility and installation criteria below. Credits assume an 11 SEER with R4.2 ducts in the attic for a direct system, and for a 13 SEER (R4.2 attic ducts) for an indirect/direct system.

Eligibility and Installation Criteria:

- Credits are allowed for single-family detached or attached residences, but not for multi-family buildings.
- Evaporative cooler ducts, if any, must satisfy all requirements applicable to conventional air conditioning ducts.
- Thermostat control is required. A two-stage thermostat with time lockout is required if second-stage or "back-up" conventional air conditioning is installed.
- Automatic relief venting must be provided to the building.
- Evaporative coolers must be permanently installed; credits are not allowed for portable window units.
- Evaporative coolers must provide minimum airflows in accord with the Air Movement and Control Association (AMCA), Standard 210, shown in Table 5.

TABLE 5: Minimum Air Movement Requirements for Evaporative Coolers		
	Minimum Air Movement (cfm/sf) (1)	
Climate Zones	Direct	Indirect/Direct
1 - 9	1.5	1.2
10 – 13	3.2	1.6
14 – 15	4.0	2.0
16	2.6	1.3
(1) – If backup air conditioning is installed, the minimum air movement for all climate zones is 1.0 cfm/sf.		

The inadequacy of the present credits as incentives effectively encouraging growth of the technology appears self-evident. Similarly, their current value appears negligible in relation to the societal benefits of an IDEC unit (for example) with maximum demand of 0.7kW, measured cooling energy savings of 70% or more, and capacity to replace a 3-ton conventional system.

4. Prior Field Monitoring Studies

Over 5 years between 1993 and 1998, DEG completed numerous advanced evaporative system monitoring and analysis projects. Most of the units involved were indirect/direct systems including six MasterCool units for SMUD in 1993, six IDEC systems for CEC/ETAP in 1994, two IDEC systems for PG&E in 1995, and four IDAC systems for PG&E in 1998. Three 1994 ("SCE") advanced direct evaporative cases are included for comparison.

Key performance values for all monitoring cases are shown in Table 6. Monitored average EER's and peak demand are crucial indicators for purposes of this paper. For simplification, EER's shown are calculated by dividing delivered cooling by total energy use. This simplified method neglects several load reduction benefits that evaporative systems offer relative to vapor compression, including elimination of latent cooling (ASHRAE sizing assumes 20% latent fraction for "dry" climates), reduced ceiling heat transfer (by exhausting house air through attic relief dampers ["upducts"]), and no house infiltration during IDEC operation (due to house pressurization). Prior studies (Hoeschele, 1994) have shown the combined effect of eliminating these loads is to boost IDEC EER, relative to air conditioning by 25%.

Average demand for the MasterCool, IDEC, and IDAC[1] systems were 1.3, 0.7 and 1.1 kW respectively, about a third or less of the average demand of a 3-ton conventional air conditioner. Measured energy efficiency ratios (EER's) are roughly double for MasterCool and IDAC, and nearly five times for IDEC, compared to current minimum standard efficiency rating for conventional air conditioning.

Similar high performance has been predicted for residential scale equipment by computer modeling and observed in laboratory and field tests, in work completed by Joe Huang of Lawrence Berkeley National Laboratory and Hofu Wu, Cal Poly Pomona *(Measurements and Computer Modeling of the Energy Usage and Water Consumption of Direct and Two-Stage Evaporative Coolers,* J. Huang, H Wu, 1992, ACEEE).

[1] 1998 IDAC monitoring was conducted at sites in Walnut Creek as indicated, under significantly lower load conditions than prevail in the valley.

Qualitatively, IDEC and other test unit occupants professed a high degree of satisfaction with their units. Occupants of the Sacramento IDEC sites offered strong testimonials for publication in support of the Sacramento region utility incentive program.

TABLE 6:
Advanced Evaporative Cooling Systems Monitoring Results

System	Year	House Sq Ft	Site Location	EER	Peak Demand (kW)	Indoor Conditions* Temp (F)	Indoor Conditions* RH (%)	Water Use (gph)
IDAC	1998	1607	Walnut Creek	26.0	1.1	76.7	61.3%	4.86
"	1998	1637	Walnut Creek	18.0	1.1	73.4	65.9%	4.51
"	1998	1649	Walnut Creek	23.5	1.2	75.9	56.6%	5.12
"	1998	2030	Walnut Creek	19.3	1.1	72.7	52.1%	4.40
Average				21.7	1.1			
IDEC	1994	1600	Sacramento	43.2	0.7	100.1/77.5	64.1%	8.4
"	1994	1300	Sacramento	51.5	0.7	96.9/80.2	65.3%	8.2
"	1994	1300	Davis	26.7	0.7	100.4/78.0	73.7%	8.7
"	1994	1000	Esparto	38.0	0.7	98.5/75.5	69.9%	7.4
"	1994	1000	Cathedral City	86.4	0.7	109.0/79.1	54.0%	7.0
"	1994	1500	Cathedral City	51.7	0.7	108.1/80.9	60.8%	10.4
Average				49.6	0.7			
IDEC	1995	1300	Davis	27.2	0.7	72.4	67.0%	10.1
	1995	1000	Esparto	30.8	0.7	73.8	74.0%	5.2
Average				29.0	0.7			
SCE	1994	2078	Palm Springs	28.7	1.6	77.2	57.0%	3.9
"	1994	1600	Cathedral City	17.9	1.1	75.8	65.5%	2.9
		1200	Palm Desert	19.1	1.1	76.7	64.9%	10.9
MasterCool	1993	1400	Sacramento	14.1	1.5	77.2	63%	24
"	1993	884	"	28.3	0.6	77.6	63%	7
"	1993	1230	"	22.0	1.1	76.7	64%	10
"	1993	1700	"	18.2	1.6	77.9	59%	12
"	1993	1058	"	10.3	1.1	74.2	67%	2
"	1993	1860	"	16.5	1.9	80.8	55%	8
Average				18.2	1.3			

IDEC indoor temperatures shown are maximum outdoor and (/) coincident indoor temperatures. Other indoor values are averages.

5. Improved Title 24 Recognition

With cooling energy conservation and peak demand reduction as priority energy policy objectives for California[2], advanced evaporative systems appear to be the leading candidate for achieving near term results. The largest manufacturer of residential evaporative coolers in the country, AdobeAir, has the high production capabilities to keep pace with increasing demand resulting from regulatory incentives.

The Energy Commission has worked with DEG and others, including Beutler Heating and Air and AdobeAir, since the early '90's on development of an optimal 2-stage system ("IDEC") for California. Development work is nearing completion and could result in a new product introduction in the near future.

[2] December 1989 CEC forecasts reported residential air conditioning accounting for only 9% annual energy use, but 58% of peak demand.

Performance comparisons between 2-stage systems and conventional air conditioning will arguably justify an "effective SEER" credit of 20 to 30 for currently available 2-stage systems. Such a credit could significantly stimulate applications in many markets not now accessible including new construction in transition, or somewhat less likely, Valley climates.

Added eligibility criteria should include a limitation that prevents the increased credit from being used to degrade envelope performance and thereby compromise cooling system viability due to higher loads. An option would be to offer a 2-Stage compliance package including streamlined compliance with adherence to design guidelines producing low to moderate cooling loads.

An alternative to ratcheting up the effective SEER to a predetermined level, would be an exceptional method approach, which would develop equivalent SEER ratings based on performance data for specific equipment. Eligibility criteria would include minimum performance levels for compliance and could also address water quality issues.

Standards documents requiring modification include the ACM Approval Manual and the Standards. Some changes to the modeling software and documentation would be required.

6. References

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