Powers Engineering

June 30, 2003

William J. Keese, Chairman and Presiding Member
James D. Boyd, Commissioner and Associate Member
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Subject: Docket Number 00-AFC-12, Addendum to June 13, 2003 Environmental Coalition Comments on PMPD for Morro Bay Modernization Project

Dear Commissioners Keese and Boyd:

Thank you for this opportunity to provide testimony on the Presiding Members' Proposed Decision (PMPD) for the Morro Bay Modernization Project (MBMP). This letter is an addendum to the June 13, 2003 environmental coalition comment letter on the PMPD. The June 13, 2003 coalition letter addressed the substantive deficiencies of the PMPD without referencing specific sections of the document. The purpose of this letter is to provide linkage between the June 13, 20003 letter and specific statements in the PMPD and elaborate as necessary on the issues involved.

Background - Coastal Replacement Power Projects and Once-Through Cooling

The proposed Morro Bay Modernization Project (MBMP) is the second project Duke Energy is developing along the California coast. The first project was the 1,060 MW Moss Landing Power Project, which is essentially identical to the MBMP. Duke received California Energy Commission (CEC) approval for Moss Landing in November 2000. Moss Landing utilizes once-through seawater cooling. Dry cooling is rejected in the November 2000 Commission Decision as infeasible on cost, adding an estimated $30,000,000 to project capital costs (pg. 160). Dry cooling is also identified as consuming 60 MW of power. A local environmental group, Voices of the Wetlands, sued the Regional Water Quality Control Board (RWQCB) in state court in July 2001 to compel compliance with the federal Clean Water Act. The lawsuit sought to vacate the permit for failure to require use of the "best technology available" for the plant's cooling water intake system, as mandated by Section 316(b) of the Clean Water Act. Voices of the Wetlands won the lawsuit in October 2002. The RWQCB was ordered to re-open the permit process.

The PMPD also notes that Duke has stated it will not build the proposed power project if dry cooling is required (pg. 309). Clearly Duke Energy has no desire to be the first merchant power plant developer in the United States to agree to construct a dry-cooled power plant in a coastal location. However, Duke's willingness to incorporate dry cooling in the MBMP should not be a factor in the CEC's determination of the appropriate cooling system for the site. An operational 1,000 MW power plant is on the site and available to California as needed. According to the

CEC,[1] *"The overall assessment remains positive as electricity supplies are expected to be adequate for at least the next two years."* California's back is not against an energy supply wall. We have adequate time to ensure that new coastal projects are built properly. Duke Energy can walk away from the table at any time and the reality is that the licensing process for a 1,200 MW power plant at the Morro Bay site is 95 percent complete. Another energy firm with less aversion to setting environmentally sustainable precedents can step in and take the licensing process to expeditious conclusion if a replacement combined-cycle project at the Morro Bay site makes sense.

316(b) Best Technology Available and Dry Cooling

The EPA cooling water intake structures 316(b) "best technology available" (BTA) analysis conducted for new facilities was done in the context of evaluating alternatives to the use of conventional once-through river or seawater cooling at power plants. The objective is to reduce the damage to marine organisms, primarily fish and marine larvae of all kinds, caused by moving hundreds of millions of gallons a day of water through a power plant cooling system. The principal alternatives identified by EPA beyond cooling intake structure refinements are evaporative wet cooling and dry cooling. Ultimately, EPA determined that dry cooling was not technically or economically feasible as a minimum standard <u>for all facilities nationwide</u>. For this reason EPA declined to identify dry cooling as BTA over evaporative wet cooling <u>on a nationwide basis</u> as the preferred alternative to once-through cooling at new facilities.

The EPA in no way intended the conclusions of the agency's 316(b) BTA analysis to preclude individual states from determining that dry cooling is indeed BTA. The EPA proposed 316(b) requirements for existing (Phase II) facilities in April 2002. The MBMP qualifies as a Phase II existing facility under 316(b) definitions. One section of the proposed Phase II 316(b) deals explicitly with dry cooling and is entitled "Why EPA is Not Considering Dry Cooling Anywhere?" (Federal Register, April 9, 2002, pg. 17168). This section of the proposed rule states:

"Although the EPA has rejected dry cooling technology as a national minimum requirement, EPA does not intend to restrict the use of dry cooling or to dispute that dry cooling may be the appropriate cooling technology for some facilities. For example, facilities that are repowering and replacing the entire infrastructure of the facility may find that dry cooling is an acceptable technology in some cases. A State may choose to use its own authorities to require dry cooling in areas where the State finds its (fishery) resources need additional protection above the levels provided by these technology-based minimum standards."

The PMPD notes on pg. 307 that the BTA must be available commercially at an economically practical cost. On the following page (pg. 308) the PMPD indicates that Duke testified that dry cooling at Alternative Site 1 would require an additional capital cost of $196 million, that at least $110 million of this cost would result from physical constraints at the site, and that the largest of these costs involves a 14- to 18-month schedule delay required because the dry cooling block must be built after the new power block construction is essentially completed. Duke's "wholly

[1] CEC, *California's 2003 Electricity Supply and Demand Balance and Five-Year Outlook*, May 2003.

disproportionate" cost argument against dry cooling is almost entirely premised on the fact that the dry cooling system for both 600 MW power blocks is squeezed into Alternative Site 1.

However, Duke does note (Exh. 168, pg. 34) that location of the dry cooling system at Alternative Site 2 would allow construction to proceed in parallel with the power block without an extension in the construction schedule. Locating 50 percent of the dry cooling system at Alternative Site 2 would create a corridor approximately 250 feet wide at Alternative Site 1 for crane access and construction staging. As noted by CEC Staff (Exh. 198, pg. 14):

"Further the applicant has not considered the time required for the excavation, placement and tie-in of the proposed once-through cooling water tunnels, as these would present similar problems in disrupting construction activities and adding time to the schedule and requiring shut down of the existing units. Another fact that the applicant did not consider is that if the ACC units do not interfere with the existing tunnels the existing units could operate without interruption until the new plant is ready to operate, which is not the case when they must tie in the new once-through system and go through startup and commissioning."

Duke's assertion that ACC will add 14- to 18-months to the construction schedule is dependent on the entire dry cooling system, two ACC blocks, being located on either Alternative Site 1 or Alternative Site 2. These site locations are shown in Exh. 232. Locating one block of ACCs on Alternative Site 1 and Alternative Site 2 will eliminate the constructability issues and significantly decrease downtime during construction relative to the once-through cooling configuration as there will be no interruptions in power generation as the new project is brought on-line.

The PMPD acknowledges on pg. 298 that Morro Bay is designated one of 28 estuaries in the United States classified as National Estuary. The entire volume of Morro Bay is cycled through the cooling structure ever 7 hours in existing plant. This would increase slightly to 8-9 hours with new plant as described in the PMPD. Morro Bay would appear to be the exact case the EPA had in mind when it stated, *"A State may choose to use its own authorities to require dry cooling in areas where the State finds its (fishery) resources need additional protection above the levels provided by these technology-based minimum standards."*

Cost Implications of Dry Cooling at Morro Bay

Duke Energy has cited spectacularly high costs for dry cooling at Morro Bay, indicating that use of dry cooling at the site would add approximately $200,000,000 to capital expenditures (PMPD, pg. 308). The additional cost cited by Duke for dry cooling at MBMP are nearly an order-of-magnitude greater than additional cost cited by the same company for a functionally identical project at Moss Landing. Would use of dry cooling at Moss Landing or Morro Bay put Duke Energy at a competitive disadvantage relative to other merchant plants competing in the same market? No. Figure 1 lists many of the power projects recently completed or in construction in California, as well as Duke Energy's 1,200 MW dry-cooled Moapa Power Plant. Duke Energy is currently building the Moapa Project in the Nevada desert to compete in the California and Nevada power markets. Figure 1 makes clear that Duke Energy has gained a major competitive advantage by using once-through cooling at Moss Landing, and that Moss Landing would still be the most cost competitive merchant power project in California if it were equipped with dry cooling. The Moss Landing Project equipped with dry cooling would remain one of the most cost competitive merchant power projects in California. It is reasonable to assume that the functionally identical MBMP would also be one of the most cost competitive merchant projects in California if equipped with dry cooling, based on the projected cost of a dry-cooled Moss Landing and the projected cost of Duke's Moapa Power Plant.

Figure 1. Comparison of Capital Cost of Selected Merchant Power Projects

Project	MW	Cooling Method	Capital Cost $ (millions)	$/kw[a]	Reference
Moss Landing	1,060	once-through	475	448	Moss Landing CEC Final Decision, pg. 2
Moss Landing[b]	1,060	dry-cooled	505	476	Ibid
Blythe	520	evaporative wet-cooled	250	481	CEC webpage, Projects Under Construction > 300 MW, June 24, 2003
Moapa	1,200	dry-cooled	600	500	Duke Energy news release, Oct. 19, 2001
High Desert	700	evaporative wet-cooled	360	514	High Desert CEC Final Decision, pg. 2
Pastoria	750	evaporative wet-cooled	400	533	High Desert CEC Final Decision, pg. 2
Metcalf	600	evaporative wet-cooled	400	667	Metcalf Energy Center homepage
Otay Mesa	510	dry-cooled	350	686	CEC webpage, Projects Under Construction > 300 MW, June 24, 2003
Elk Hills	550	evaporative wet-cooled	395	718	Sempra Energy Resources homepage

a. The capital cost of power projects is typically stated in terms of "$/kw."
b. The Moss Landing CEC Final Decision indicates a $30,000,000 incremental cost for dry cooling.

Plant Design Capacity, PMPD Pg. 30

The PMPD states: *The Project objective is to construct and operate a 1,200 MW natural gas-fired, combined-cycle merchant power plant using existing infrastructure in the City of Morro Bay.* The PMPD does not distinguish between the 1,200 MW at 85 ^{o}F project that Duke initially discussed in the January 7, 2002 *Updated Analysis of Alternative Cooling Systems for the Morro Bay Modernization Project* (Exh. 167) and the 1,200 MW at 57 ^{o}F project that Duke described in the October 2000 Application For Certification (Exh. 4). As the ambient temperature increases, air becomes less dense, the mass of air passing through the turbine decreases, and less power is produced. A project designed to produce 1,200 MW at 85 ^{o}F can produce in the range of 1,350

MW to 1,400 MW at 57 ^{o}F. This is a considerably larger installation than that analyzed by CEC staff in the Final Staff Assessment (FSA). The PMPD finds fault with CEC staff, and the CCC, for basing their assessments on the feasibility of dry cooling on a flawed analysis in the FSA. The PMPD does not acknowledge that Duke's 1,200 MW at 85 ^{o}F project actually represents 1,350 to 1,400 MW at 57 ^{o}F, a 11 to 17 percent increase in plant capacity over the plant proposed in the AFC.

Duke sidesteps this issue in *Comments on Draft Appendix A: Morro Bay Power Plant Cooling Options Report, February 15, 2002* (Exh. 168, pg. 10, Figure 1), by showing the project maintaining a flat output of 1,200 MW from 55 ^{o}F to 74 ^{o}F, while the duct-fired option evaluated by the CEC drops from 1,200 MW to 1,000 MW as the ambient temperature increases from 55 ^{o}F to 74 ^{o}F. Figure 1 is attached to this letter as Attachment A. Figure 1 is incorrect. Gas turbine power plants do not produce flat power output across the site temperature range. The only exception to this rule is when a mechanical chiller is used to maintain turbine inlet air temperature at a specific temperature, such as 45 ^{o}F or 50 ^{o}F, regardless of the ambient temperature. The PMPD is explicit (pg. 83) that the gas turbines will not utilize inlet air cooling. Duke is unequivocal in the AFC that the plant will be designed to achieve an output of 1,200 MW at average ambient site temperature. Duke's currently proposed project will produce 1,350 to 1,400 MW at 57 ^{o}F, the average site temperature at Morro Bay.

Duct Firing, PMPD pgs. 83-86

The duct firing discussion in the PMPD contains a number of errors. Air inlet cooling is the only option available for maintaining fuel efficiency while increasing combined-cycle plant output. The PMPD states on pg. 83 that the project will not include inlet air cooling. Duct burners increase output at the expense of decreased fuel efficiency. The addition of air-cooled mechanical chillers to the project, designed with sufficient cooling capacity to maintain inlet gas turbine air temperature to 53 ^{o}F on an 85 ^{o}F day, would leave the plant heat rate unchanged from the unfired case (the maximum fuel efficiency baseline) and add 78 MW (net) to plant output. In contrast, use of duct burners alone to increase output on an 85 ^{o}F day decreases overall plant fuel efficiency by approximately 5 percent.[2] The addition of a modest amount of duct firing to turbines employing mechanical chillers for inlet air cooling would allow the plant to provide 1,200 MW at 85 ^{o}F with a minimal fuel efficiency penalty. This approach would also greatly reduce the peak cooling load on the steam turbine condenser, resulting in a much smaller air-cooled condenser (ACC).

A preliminary design for the mechanical chiller cooling system is provided in Attachment B. The cost of this mechanical chilling capacity is estimated at $12,000,000 to $15,000,000 for the MBMP plant configuration.[3]

[2] PMPD, pg. 85. Unfired heat rate, 6,865 Btu/kwh. Fired heat rate, 7,200 Btu/kwh. Increase in heat rate = 4.9%.
[3] E-mail from Turbine Air Systems to B. Powers, June 26, 2003. Equipment cost for 12,500 tons of air-cooled refrigeration for two S207FA blocks estimated at $8,000,000 to 10,000,000. Installation estimated by B. Powers at 50% of equipment cost.

Power produced from duct firing in a combined-cycle power plant is no more efficient than power produced in simple-cycle gas turbines or the existing utility boilers at Morro Bay that the MBMP is intended to replace. Duke estimates that the heat rate of power produced from duct firing will be 8,710 Btu/kwh (Exh. 200E). This compares to a heat rate of approximately 8,900 Btu/kwh for the most common peaking turbine installed in California in the last two years, the LM6000PC.[4]

The PMPD makes the statement (pg. 84) that "*Although inclusion of duct burners is less efficient than overall operation of the combined cycle technology, Staff concluded it provides additional benefit for capacity and is more efficient than other technology for providing energy during peak conditions.*"

The Staff conclusion is incorrect in this case. As noted above, inlet air cooling is the most fuel efficient means of increasing output. Peaking turbines have typically operated well under 500 hours/year in California with the exception of the energy "crisis" anomaly of 2000-2001. CEC staff corrected stated that *"inclusion of duct burners is less efficient than overall operation of the combined-cycle technology."* The oversized steam cycle equipment necessary to provide 1,200 MW at 85 ^{o}F, through massive duct firing, will add a fuel efficiency penalty of approximately 60 Btu/kwh during baseload unfired operation.[5] The MBMP will consume approximately 350,000 MMBtu/yr more fuel to maintain output during baseload operation relative to a plant designed without duct firing.[6] The duct burners will consume approximately 1,200,000 MMBtu/yr of fuel assuming 500 hours/year at maximum firing rate.[7] The duct burner heat rate stated by Duke does not take into account the fuel penalty caused by operating a massively duct fired combined-cycle power plant with the duct burners off most of the time. When this wasted fuel is added to the actual duct burner fuel use, the net heat rate of the duct burner generated power would actually be:

8,710 Btu/kwh x [(1,200,000 + 350,000)/1,200,000] = 11,250 Btu/kwh

11,250 Btu/kwh is poor heat rate, for a simple-cycle turbine or a 1970s vintage utility boiler. It is also worth noting that Morro Bay is far from any major California urban center. Transmission congestion and transmission line losses are greatest during periods of peak demand. The net heat rate of duct burner power produced at Morro Bay, would be considerably higher than 11,250 Btu/kwh if transmission losses were taken into consideration. All peaker plants built in response to the energy "crisis" of 2000-2001 have been built within relatively close proximity of major California urban centers.

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[4] Gas Turbine World, 2001-2002 Handbook, pg. 32. Assume high heating value (HHV) is 1.1 times low heating value (LHV) heat rate shown in table.

[5] Powers Engineering PowerPoint presentation on dry cooling for intervenor CAPE, March 12, 2002 CEC MBMP workshop, Morro Bay, CA.

[6] Assume 500 hours/year at full duct fire and a capacity factor of 0.7 during the remaining 8,260 hours/year with duct burners off. Assumed average plant output during unfired operation is 1,028 MW.

[7] AFC Table 6.2-1.3 indicates duct burner heat input per turbine at 85 ^{o}F of 426 MMBtu/hr. This is for plant producing 1,200 MW at 57 ^{o}F. Assume duct burner heat input is 600 MMBtu/hr per turbine for 1,200 MW at 85 ^{o}F configuration.

Alternative Cooling Options, PMPD pgs. 304 – 325

The Alternative Cooling Options of the PMPD relies almost exclusively on Duke Energy testimony to support the finding that the dry cooling alternative is not feasible. As the PMPD correctly notes (pg. 309), *"Applicant knows it would not build the proposed power plant project if dry cooling were required."* It is unclear why the Presiding Commissioners assume they must have the consent of the applicant before requiring a plant system, in this case dry cooling, that will completely protect a critical California resource while adding a very nominal additional cost to the project capital budget.

The PMPD states (pg. 307) that *"Staff has attempted to restate the objectives of the Project to eliminate or severely reduce duct-firing capacity."* This is an incorrect statement. Duke Energy is explicit in the AFC that the capacity of the proposed project is 1,200 MW at the average site temperature. Average site temperature is 57 ^{o}F. Duke later restated the project objective as 1,200 MW at 85 ^{o}F. This equates to a capacity of 1,350 to 1,400 MW at 57 ^{o}F. As CEC Staff correctly pointed out (Exh. 198, pg. 12), the sole purpose of this restatement by Duke was to maximize the cooling load on the air-cooled condenser. Staff state: *"By insisting on a capacity of 1,200 MW at 85 ^{o}F, the applicant is attempting to persuade the Commission that alternative cooling forces them into the position that the footprint of the ACC is too large to fit into the available space for the Alternate 1 location."*

The PMPD lauds Duke evaluation of the dry cooling alternative (pg. 313), stating that *"Applicant has set forth a detailed and persuasive set of problems which make construction of adequate dry cooling at the Project site extremely expensive, time consuming, unsafe, and fundamentally infeasible."* Given Duke stated from the onset that it would kill the MBMP if dry cooling were required, this should not have come as a surprise. In reality, Duke created a set of problems out of whole cloth that do not bear up under serious scrutiny. The CEC Staff rebuttal (Exh. 198) does an effective job of debunking most of the substantive "problems" raised by Duke in their dry cooling analysis.

The PMPD dismisses technically accurate analyses of the dry cooling alternative by CEC staff and myself in a single sentence (pg. 314), *"We find this approach by witnesses for both Staff and CAPE to be unconvincing and lacking in specificity."* One of my comments was very specific (6/5/02 RT 241:20-25) and addressed the issue of ACC constructability and height at the Alternative 1 site location – place one ACC on the Alternative 1 site and the second ACC on the Alternative 2 site. This commonsense approach eliminates the space limitation issue used by Duke to reject both the Alternative 1 and Alternative 2 sites.

Space limitation at the Alternative 1 site was the only concrete reason offered by Duke's dry cooling expert witness, Mr. Frank Ortega, for identifying dry cooling as infeasible at the Morro Bay site (PMPD, pg. 312). Mr. Ortega cross-examined me at length regarding the locating ACC's at the Alternative 1 and Alternative 2 sites (6/5/02 RT 255-258), though at no time did he indicate that he thought that the use of both sites was infeasible. It was my expectation that the Presiding Commissioners would direct CEC Staff to investigate the feasibility of my suggestion that the ACCs for the two 600 MW blocks be placed in separate locations to eliminate the space limitations at the Alternative 1 site following the June 5, 2003 evidentiary hearings. Apparently this was not done.

Mr. Ortega also pointed-out that the ACC designs proposed by CEC staff and Duke represented an "initial temperature difference" (ITD) of approximately 60 ^{o}F (6/5/02 RT 121), and that more recent ACC designs typically have more conservative ITDs in the range of 40 to 45 ^{o}F. Use of the 40 to 45 ^{o}F ITD design guideline would result in an ACC with approximately 30 percent more cells according to Mr. Ortega (6/5/02 RT 120). In reality the MBMP will operate in duct fire mode for a small portion of the year. For most of the year the plant will operate in unfired mode in a very temperate environment. Given the very moderate annual average temperature of 57 ^{o}F and the fact that the site temperature is at or above 74 ^{o}F only 1 percent of the year (Exh. 198, pg. 12) a 40 to 45 ^{o}F ITD would be an extremely conservative design guideline. Duke states that the 1,200 MW project will have a steamflow to the condenser of 1.642 million lb/hr with duct firing, and 1.097 million lb/hr without duct firing. An ITD of 60 ^{o}F for the 1.642 million lb/hr fired case, and 50 ^{o}F for the 1.097 million lb/hr unfired case, would result in efficient ACC operation under baseload operating conditions and allow rated steam turbine power output on hot days.

I requested such an ACC design from Hamon Dry Cooling in June 2003. The results are provided in Attachment C. The proposed ACC design consists of 36 cells per 600 MW block, a total height of 75 feet, and ultra-low noise fans. At full duct firing the ITD is approximately 60 ^{o}F. At average annual site temperature and no duct firing the ITD is approximately 50 ^{o}F (2.3-inches at 57 ^{o}F). The PMPD states that Alternative Site 1 is 575 feet wide (pg. 260). The ACC shown in Attachment C for one 600 MW power block is 300 feet wide. At a height of 75 feet the ACC is 20 feet lower than the two heat recovery steam generators associated with one 600 MW power block.

Duke is also disingenuous when attempting to paint Mr. Ortega as someone who *"came up here on his own – he does not even work for Duke . . .."* (6/5/02 RT 262). It makes no sense that the business manager of an ACC manufacturing firm would make a voluntarily trip to Morro Bay to denounce the only product his company makes at a site that is nearly perfect for that technology. GEA Power Cooling Systems, Mr. Ortega's employer, is currently constructing the ACC at Duke's 1,200 MW Moapa Power Plant in Nevada (6/5/02 RT 143). GEA also provides dry cooling quotes for other Duke projects under development. GEA has a lot to lose if the company does not comply with special requests from major customers like Duke Energy.

Thank you for this opportunity to comment on the PMPD. Please call me at (619) 295-2072 if you have any questions about the comments contained in this letter.

Sincerely,

Bill Powers, P.E.