

Diablo Canyon: 78 Percent of California Coastal Power Plant Once-Through Cooling Water Withdrawals

Bill Powers, P.E., November 23, 2013

The average annual capacity assumed by Bechtel for Diablo Canyon is 90 percent.¹ Assuming a 90 percent capacity factor, the total annual once-through cooling water throughput at Diablo Canyon is 816 billion gallons per year.^{2,3}

In contrast, the approximately 15,964 MW of coastal once-through cooled steam boiler capacity operates on average with a low capacity factor of 4.1 percent.⁴ Annual coastal steam boiler once-through cooling water throughput, assuming the circulating water pumps are not in use when the coastal steam units are not producing electricity, would be about 158 billion gallons per year.⁵

There is approximately 1,900 MW of coastal once-through cooled combined cycle plant capacity.⁶ These combined cycle units operate with an average capacity factor of about 37 percent.⁷ Annual coastal combined cycle once-through cooling water throughput, assuming the circulating water pumps are not in use when the combined cycle units are not producing electricity, would be about 73 billion gallons per year.⁸

The total once-through cooling water withdrawal rate of California coastal power plants, following the retirement of San Onofre, is approximately: 816 billion gallons/yr (Diablo Canyon) + 158 billion gallons/yr (coastal boiler plants) + 73 billion gallons/yr (coastal combined cycle plants) = 1,047 billion gallons/yr. Diablo Canyon once-through cooling withdrawals

¹ Bechtel, *Final Technologies Assessment for the Alternative Cooling Technologies or Modifications to the Existing Once-Through Cooling System for Diablo Canyon Power Plant*, September 20, 2013, p. 75.

² TetraTech, *California's Coastal Power Plants: Alternative Cooling System Analysis*, February 2008, Chapter C – Diablo Canyon Power Plant, Table C-5, p. C-10. Cooling water flowrate per unit = 862,690 gpm.

³ $2 \text{ units} \times (862,690 \text{ gallon/min per unit})(60 \text{ min/hr})(24 \text{ hr/day}) = 2.485 \text{ billion gallon/day} \times 365 \text{ days/yr} \times 0.9 = 816 \text{ billion gallons per year.}$

⁴ CEC, *Staff Report – Thermal Efficiency of Gas-Fired Generation in California: 2012 Update*, March 2013, Table 2, p. 5. Capacity of aging steam boiler plants = 15,964 MW. 2011 aging steam boiler plant capacity factor = 4.1%. 2011 combined cycle capacity factor = 36.8%.

⁵ TetraTech, *California's Coastal Power Plants: Alternative Cooling System Analysis*, February 2008, Chapter O (803 MW Scattergood Generating Station) p. O-3. Scattergood cooling water flowrate = 344,000 gpm. Unit once-through cooling water usage rate = $(344,000 \text{ gpm} \times 60 \text{ min/hr})/803 \text{ MW} = 25,704 \text{ gallons/MW-hr}$. Assuming the Scattergood unit cooling water usage rate is representative of coastal natural gas-fired steam units, the annual cooling water throughput for coastal steam boilers collectively would be: $15,964 \text{ MW} \times 8,760 \text{ hr/yr} \times 0.041 \times 27,504 \text{ gallons/MW-hr} = 158 \text{ billion gallons per year.}$

⁶ These combined cycle units include: Moss Landing Units 1&2, 1080 MW; Harbor Unit 5, 235 MW; and Haynes Unit 8, 575 MW. Total California coastal once-through cooled combined cycle capacity = 1,080 MW + 235 MW + 575 MW = 1,890 MW.

⁷ TetraTech, *California's Coastal Power Plants: Alternative Cooling System Analysis*, February 2008, Chapter J (Moss Landing Power Plant, 1,080 MW Units 1&2) p. J-2. Units 1&2 combined cycle once-through cooling water flowrate = 214,000 gpm. Unit once-through cooling water usage rate = $(214,000 \text{ gpm} \times 60 \text{ min/hr})/1,080 \text{ MW} = 11,889 \text{ gallons/MW-hr}$.

⁸ Assuming the Moss Landing Units 1&2 unit cooling water usage rate is representative of coastal once-through cooled combined cycle units, the annual cooling water throughput for coastal combined cycle units collectively would be: $1,900 \text{ MW} \times 8,760 \text{ hr/yr} \times 0.37 \times 11,889 \text{ gallons/MW-hr} = 73 \text{ billion gallons per year.}$

represent about 78 percent of total California once-through cooled coastal power plant ocean water withdrawals (816 billion gal/yr \div 1,047 gal/yr = 0.779, or 77.9 percent).

The coastal steam boiler plants account for about 15 percent of once-through cooling withdrawals. The once-through cooled coastal combined cycle plants account for about 7 percent of once-through cooling withdrawals.⁹

⁹ Diablo Canyon once-through cooling withdrawals = 816 billion gallon/yr. Coastal steam boiler withdrawals = 158 billion gallons per year. Coastal once-through cooled combined cycle withdrawals = 73 billion gallons per year. Total annual withdrawals = 1,047 billion gallons per year. Percentage nuclear = 78%. Percentage steam boiler = 158 billion gal/yr \div 1,047 billion gal/yr = 0.15, or 15%. Percentage combined cycle = 73 billion gal/yr \div 1,047 billion gal/yr = 0.07, or 7%.