Alternative Cooling System Analysis: California’s Coastal Power Plants

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Once-through Cooling: Results Symposium
University of California
Davis, California
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El Segundo
1. Study Purpose
2. Feasibility
3. Methods / Assumptions
4. Cost
5. Maulbetsch Consulting Study
Purpose & Parameters

– 2006 OPC Resolution on Once-through Cooling:

“implement the most protective controls to achieve a 90-95 percent reduction in impacts [from impingement and entrainment]”

– Scope of Work:

“report will not analyze impingement and entrainment levels at each plant nor...the specific decrease in impingement and entrainment achieved by...each alternative cooling technology”

– Repower vs. Retrofits
Some Feasibility Issues

- IM & E Reduction
- Land Use
- System Tolerances

Technical & Logistical
Some Feasibility Issues

Local Use Restrictions
- Noise
- Building Height
- Visual

Technical & Logistical
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- Land Use
- System Tolerances
Some Feasibility Issues

Other Effects

- Air Emissions
- Water Discharge
- Social / Cultural

Local Use Restrictions

- Noise
- Building Height
- Visual

Technical & Logistical

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- Land Use
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- Noise
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Some Feasibility Issues

- Technical & Logistical
  - IM & E Reduction
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- Local Use Restrictions
  - Noise
  - Building Height
  - Visual

- Other Effects
  - Air Emissions
  - Water Discharge
  - Social / Cultural

- Total Cost
  - Grid Reliability
  - Age and Utility
Methods / Assumptions

General Assumptions:
- Provide sufficient cooling for active capacity
- Salt water use for makeup water
- Condenser reinforcement; no re-optimization

Engineering Profile:
- Facility-specific data & local zoning
- Develop conceptual design
- Design-and-build estimate from CT vendors (GEA and SPX/Marley)
- Professional estimators for mechanical, electrical, civil works
Technical / Logistical Feasibility

REDONDO BEACH

- 4 active units / 1,300 MW
- 612,000 gpm
- Noise limit: 55 dBA
- Nearest building < 80 feet
ORMOND BEACH

- 2 active units / 1,500 MW
- 476,000 gpm
- Pt. Mugu NAS ~ 2.5 miles SE
- Conservation areas
Technical / Logistical Feasibility

- El Segundo
- Ormond Beach
- Redondo Beach

- Alamitos
- Diablo Canyon
- Mandalay
- Moss Landing
- Morro Bay
- San Onofre

- Contra Costa
- Harbor
- Haynes
- Huntington
- Pittsburg
- Scattergood
Cost Estimate

Direct:
- All civil, mechanical and electrical; including cooling tower design-and-build

Indirect:
- 30% of all direct costs (35% for Diablo and SONGS)

Contingency:
- 25% of all direct costs (30% for Diablo and SONGS)

Energy Penalty:
- Parasitic load and efficiency change
Annual Energy Penalty Estimate (%)

- Harbor
- Moss
- Haynes
- Mandalay
- El Segundo
- Contra Costa
- Alamitos
- Huntington
- Ormond
- Pittsburg
- Scattergood
- San Onofre
- Diablo

Legend:
- Fan
- Pump
- Efficiency

Note: w/ combined cycle and nuclear
OM & EP based on 2006 output rate
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<th>MC</th>
<th>Cell Flow ((gpm))</th>
<th>TT</th>
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<td>11,000 – 16,500</td>
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<td>2,500</td>
<td>Cell Footprint ((ft^2))</td>
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<td>~1,000</td>
<td>Piping ((ft / tower))</td>
<td>500 – 4,000</td>
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<td>~40</td>
<td>Pump Head ((ft))</td>
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<tr>
<td>200</td>
<td>Fan Power ((hp / cell))</td>
<td>200 – 270</td>
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<td>Location</td>
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<td>Number of Cells</td>
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<tr>
<td>Scattergood</td>
<td><strong>2.03%</strong></td>
<td><strong>1.10%</strong></td>
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</table>

*TT: Unable to design preferred option; represents conventional design
Summary

- Wet cooling retrofits reduce impingement and entrainment impacts by ~95%, plus thermal discharge reductions

- 12 of 15 facilities considered “technically feasible” in this study

- “Feasible” facilities still face hurdles

- Capital cost: 255 to 524 $/gpm
- NPC: 324 to 1,334 $/gpm