Issues Associated with Retrofitting Coastal Power Plants

John S. Maulbetsch

Once-through Cooling: Results Symposium

University of California
Davis, California

January 16, 2008

Topics for the next 20 minutes

- Estimating capital costs of retrofit
- Some comparisons
- Additional costs of retrofitting

Estimating capital costs

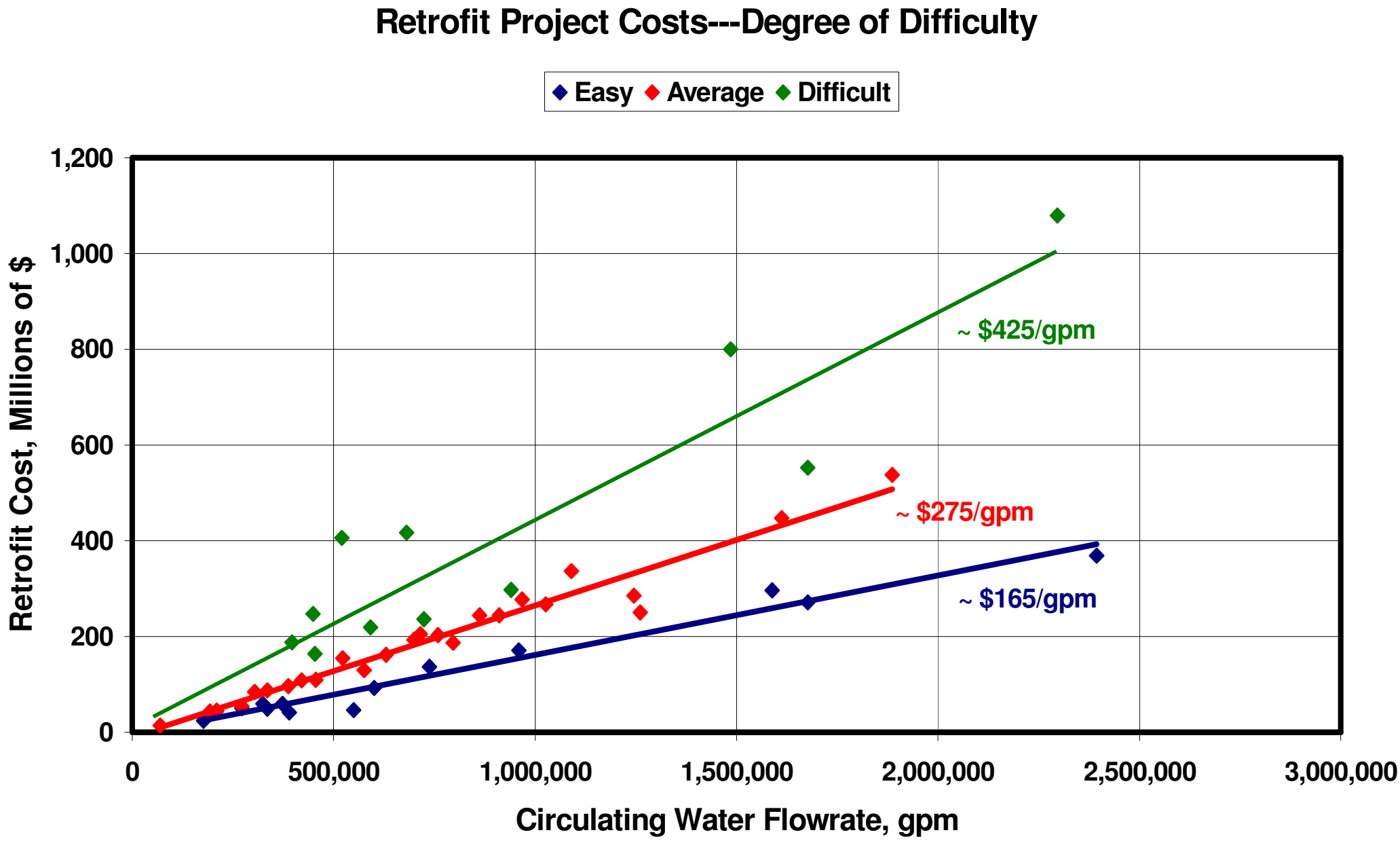
Two approaches

1. **Bottom up---build up from design, component costs and installation costs**
2. **Top down---**
   - **Establish a range based on known costs of other projects**
   - **Place in range based on a "degree of difficulty" judgment**

Establishing the range

- Correlation of reported project costs
  - 50 plants
  - Coal/gas/nuclear
  - Fresh/brackish/saline water source
  - Wide range of climates
- Circulating water flow used as correlating factor
- Costs fell into three clusters
  - Low; average; high

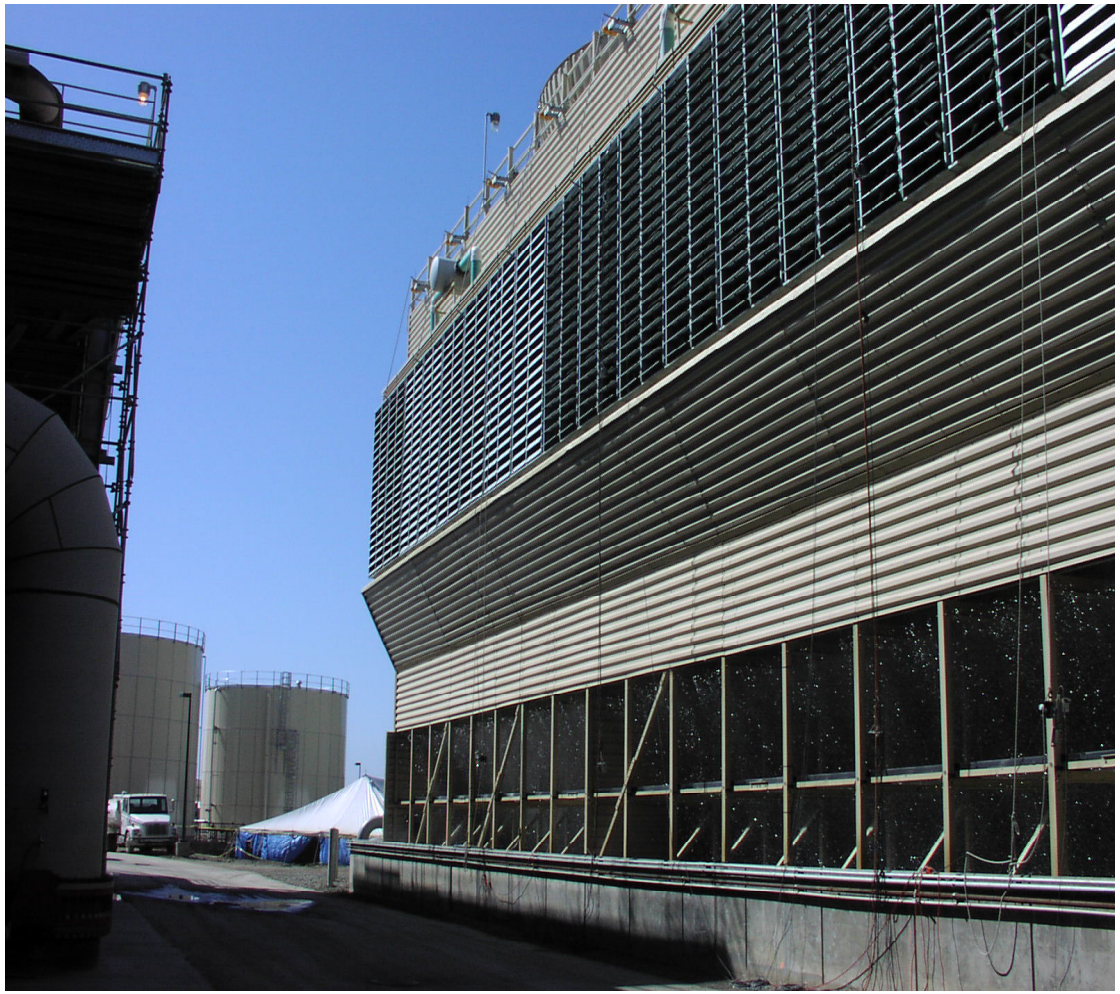
Graphical correlations



Things that set degree of difficulty

- **Siting tower**
  - **Relocation of structures**
  - **Land acquisition**
  - **Grading of site for gravity return**
- **Excavation for circ. water lines and sump**
  - **Interferences**
  - **Soil conditions**
    - **Wet, unstable**
    - **Bedrock**
    - **Contaminated**

More things



- **Noise control**
  - **Special fans**
  - **Wind walls**
- **Plume abatement**
  - **Higher cost tower**
  - **Harder to site**

Another thing

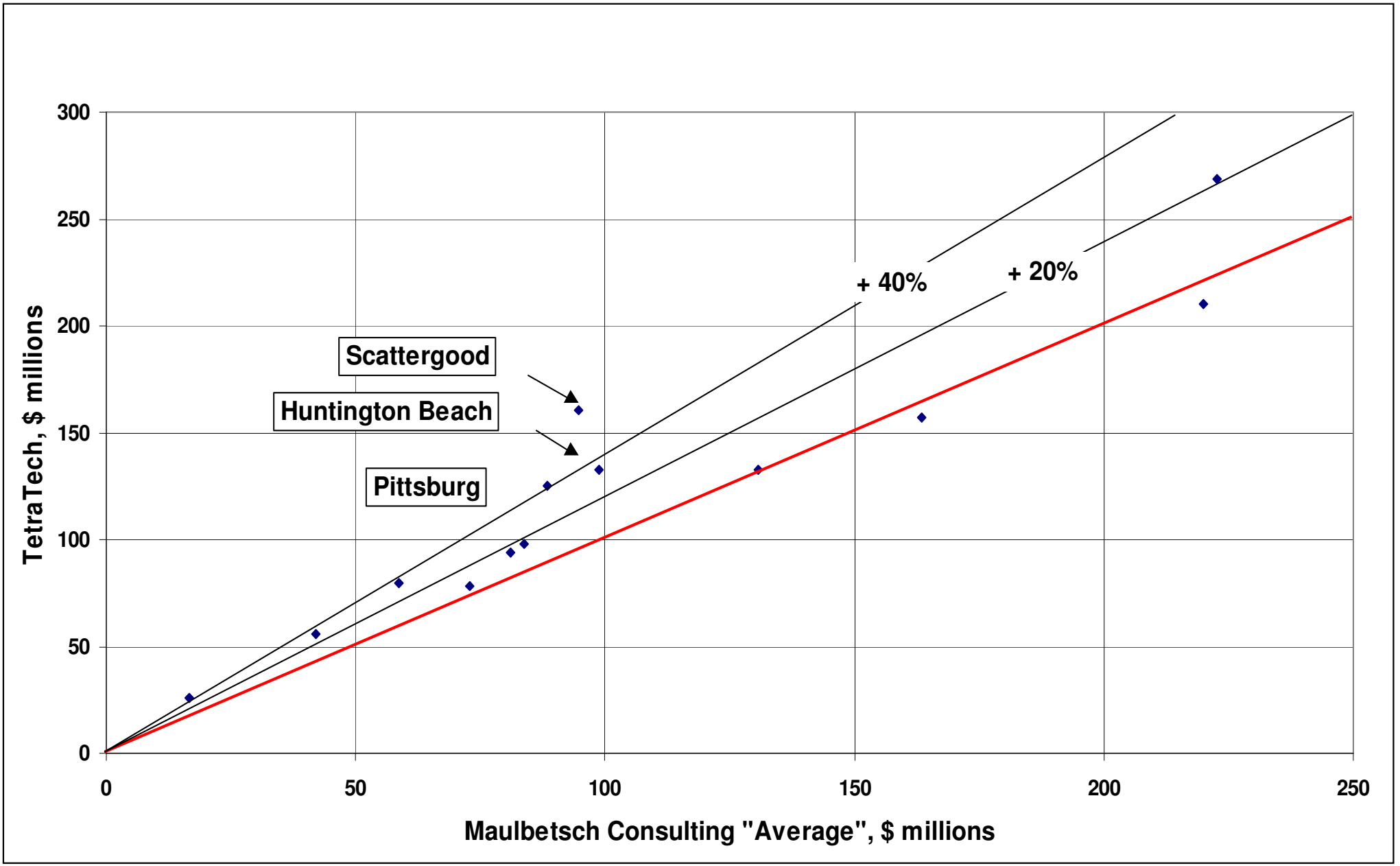
Base-load plant with long remaining life

- **Re-optimize**
  - **Lower circulating water flow**
  - **Higher range**
- **Probable re-tubing of condenser**
- **Relocation of inlet exit lines**
- **Extended outage for modifications**

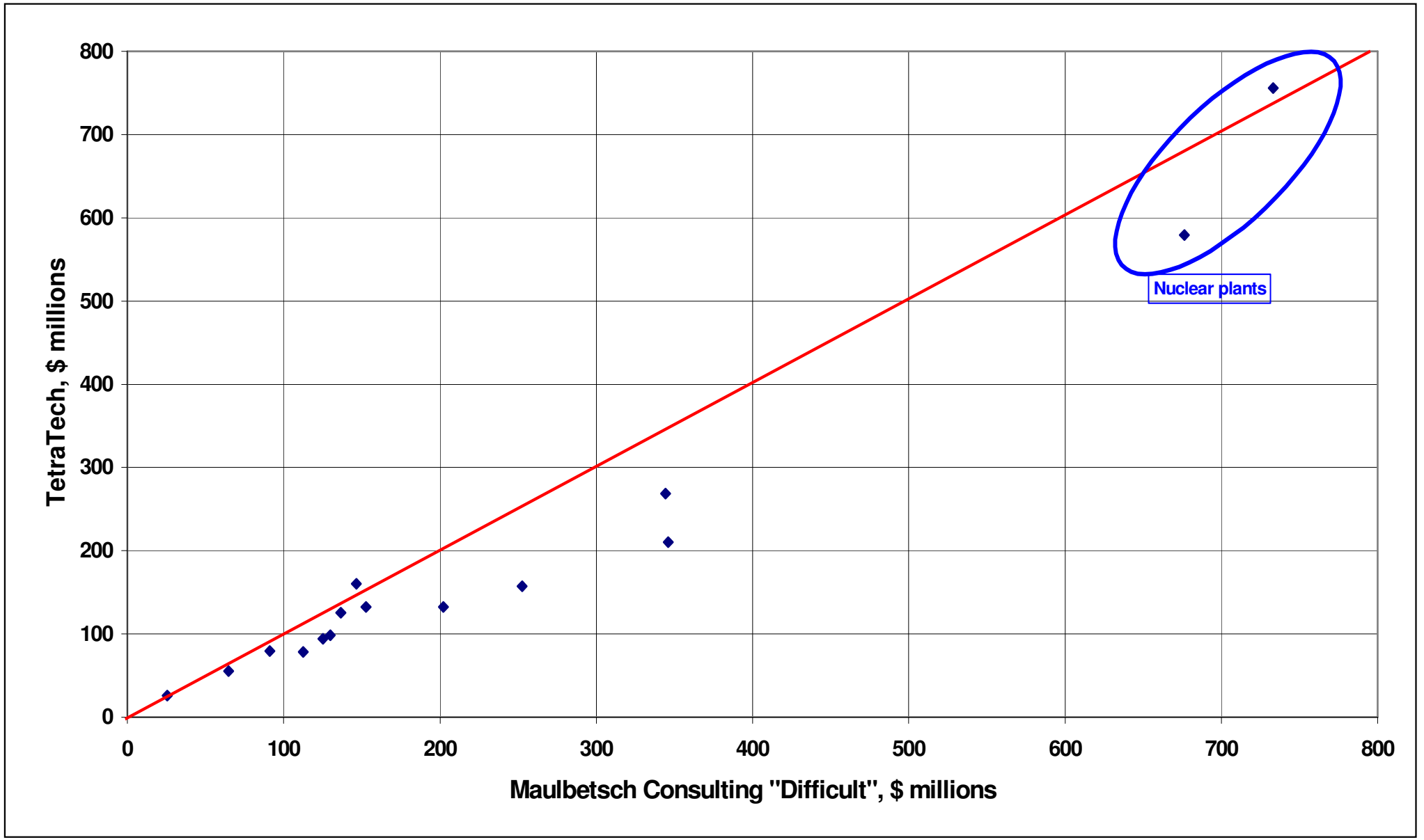
Some comparisons

- **Maulbetsch Consulting/TetraTech**
  - **Direct comparison at 15 plants**
  - **MC/TT = 1.03 (Total for all 15 plants)**

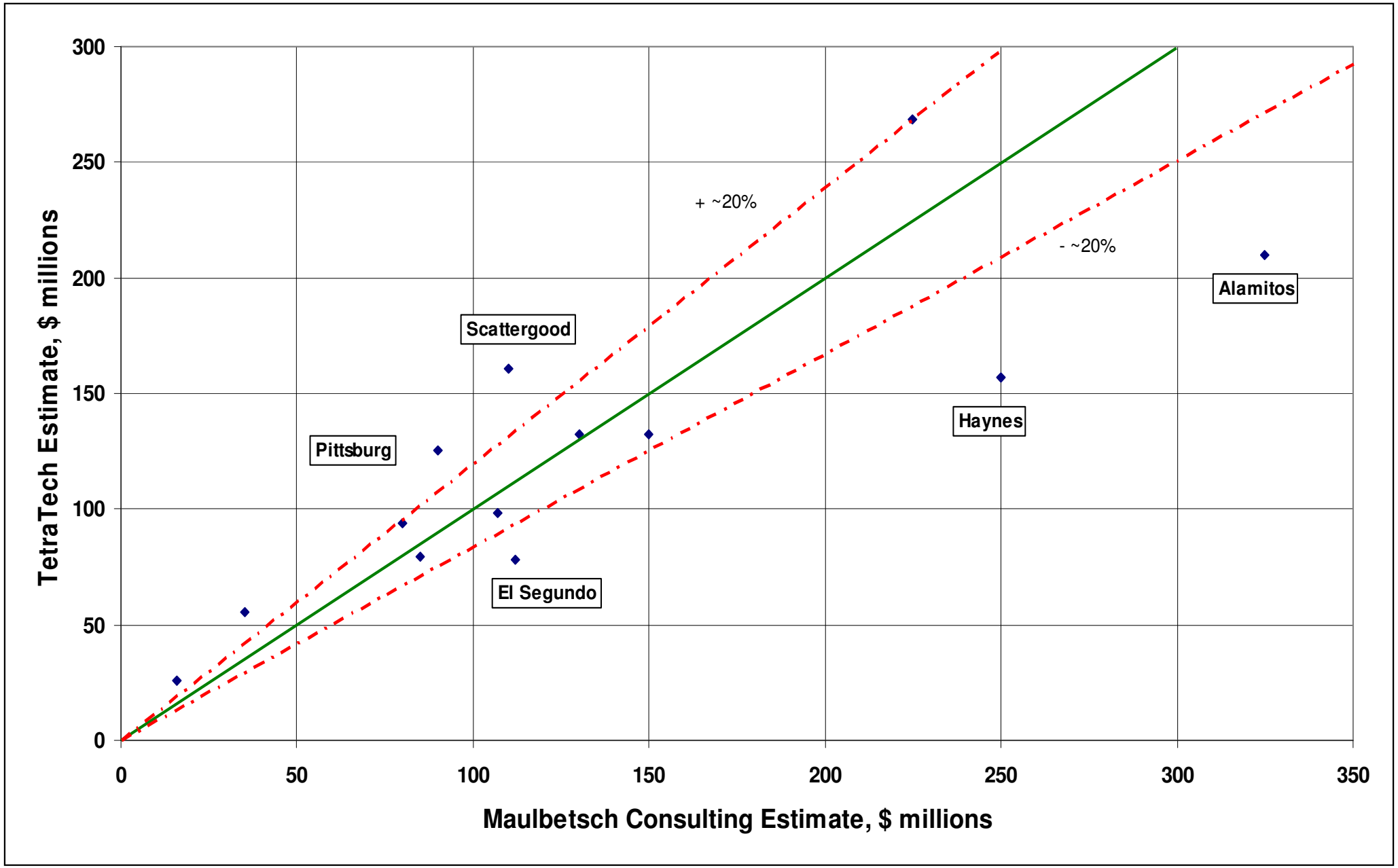
Comparison with "Average"



Comparison with “Difficult”



Comparison with Estimate



Plants with differences

- **Alamitos: 6 units; 1982 MW; 800,000 gpm**
  - **MC; rated as "difficult" ($325 million)**
    - **Plume abatement**
    - **High circ. water line installation costs**
    - **Demolition costs**
  - **T'Tech ($210 million; ~ MC "average")**
    - **No plume abatement (~ $60 million)**
    - **3 towers vs. 6 towers (large savings on circ. line costs)**

Plants with differences

- **Scattergood: 3 units; 803 MW; 344,000 gpm**
  - **MC; rated as "average" to "difficult" ($120 MM)**
    - **Plume abatement**
    - **One tower per unit**
    - **Moderate but not severe line costs**
  - **T'Tech ($160 million; > MC "difficult")**
    - **Plume abatement**
    - **Two towers for Unit 3**
    - **Costs related to switchyard**
    - **Noise abatement**

Additional (non-capital) costs

- **Drift/PM10 offsets**
- **Plant downtime**
- **Land acquisition/security zone enhancement**
- **Permitting time**

Drift/PM10 Offsets

- **Assuming**
  - **Seawater make-up**
  - **Drift eliminators spec'd at 0.0005%**
  - **All drift solids considered PM10**
- **For a 250 MW plant operating at 80% c.f**

PM10 emissions ~ 60 tons/year

Plant downtime

- **Primarily affected by tie-in to condenser and intake/discharge facilities**
- **Estimates vary from < 1 month to ~ 1 year**
- **If condenser is re-optimized, time is <u>much</u> longer**
- **Costs are dependent on scheduling**

Land acquisition/security zone

- **Situations where insufficient area is available on-site**
- **Establish a buffer zone from near neighbors**
- **Special considerations for nuclear plants….**
  - **Location of tower may extend security zone**
  - **Additional fencing, perimeter monitors, etc.**
  - **Increased security staff**

Permitting costs

- **No basis for estimating but might be substantial**
  - **Significant time requirements**
  - **Legal and consulting assistance**

Operating costs

- **Additional operating power requirements**
  - **Pumping power**
  - **Fan power**
- **Penalty costs—effect of cooling system on plant performance**
  - **Heat rate**
  - **Plant capacity**

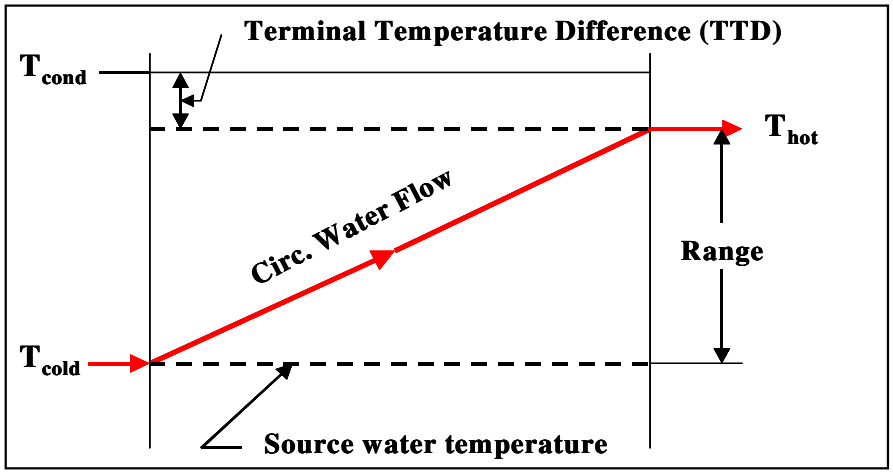
Additional pumping power

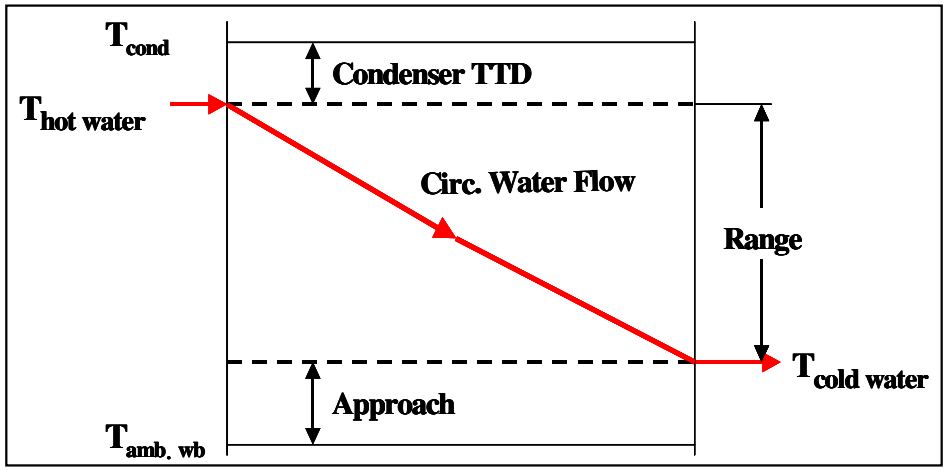
- Head losses in circ. water lines
- Getting water to top of tower
- Assume….
  - 1000’ line
  - 40’ rise
- **Pump power ~ 0.5%**

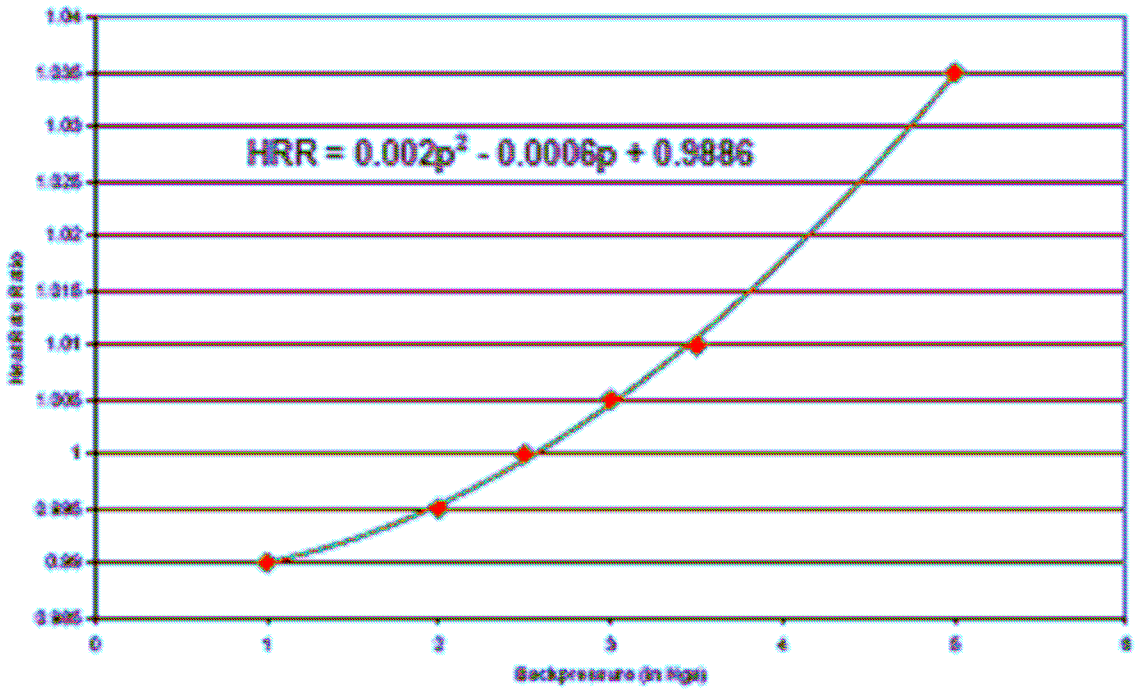
Fan Power

- ~ 10,000 gpm/cell
- ~200 HP fan
- Fan power ~ 1%

Effect on condensing temperature







Cold water comparisons