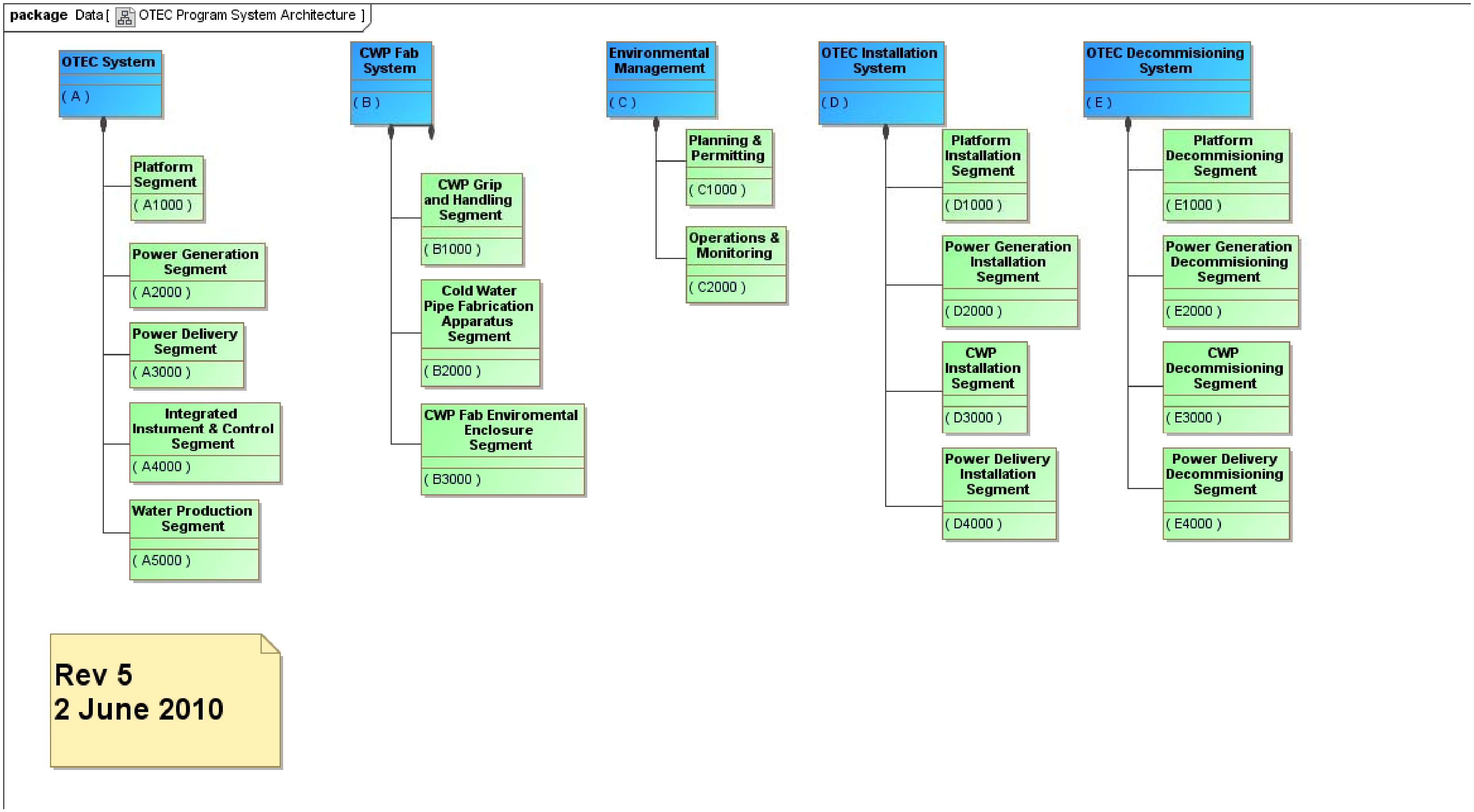
OTEC Overview

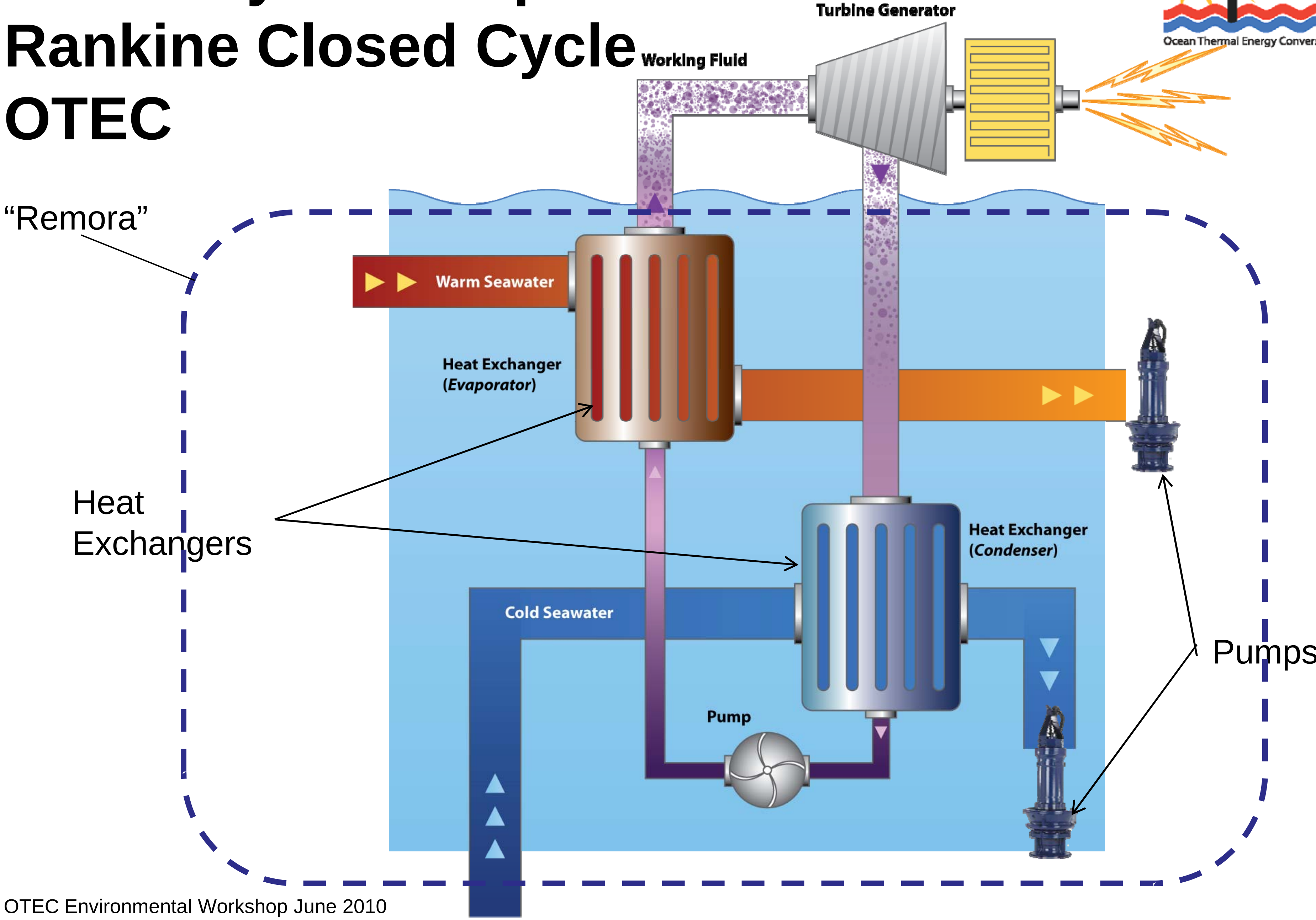
Workshop on Ocean Thermal Energy Conversion (OTEC): Assessing Potential Physical, Chemical and Biological Impacts and Risks

June 22, 2010

Anatomy of an OTEC System



Power Cycle: Simple Rankine Closed Cycle OTEC



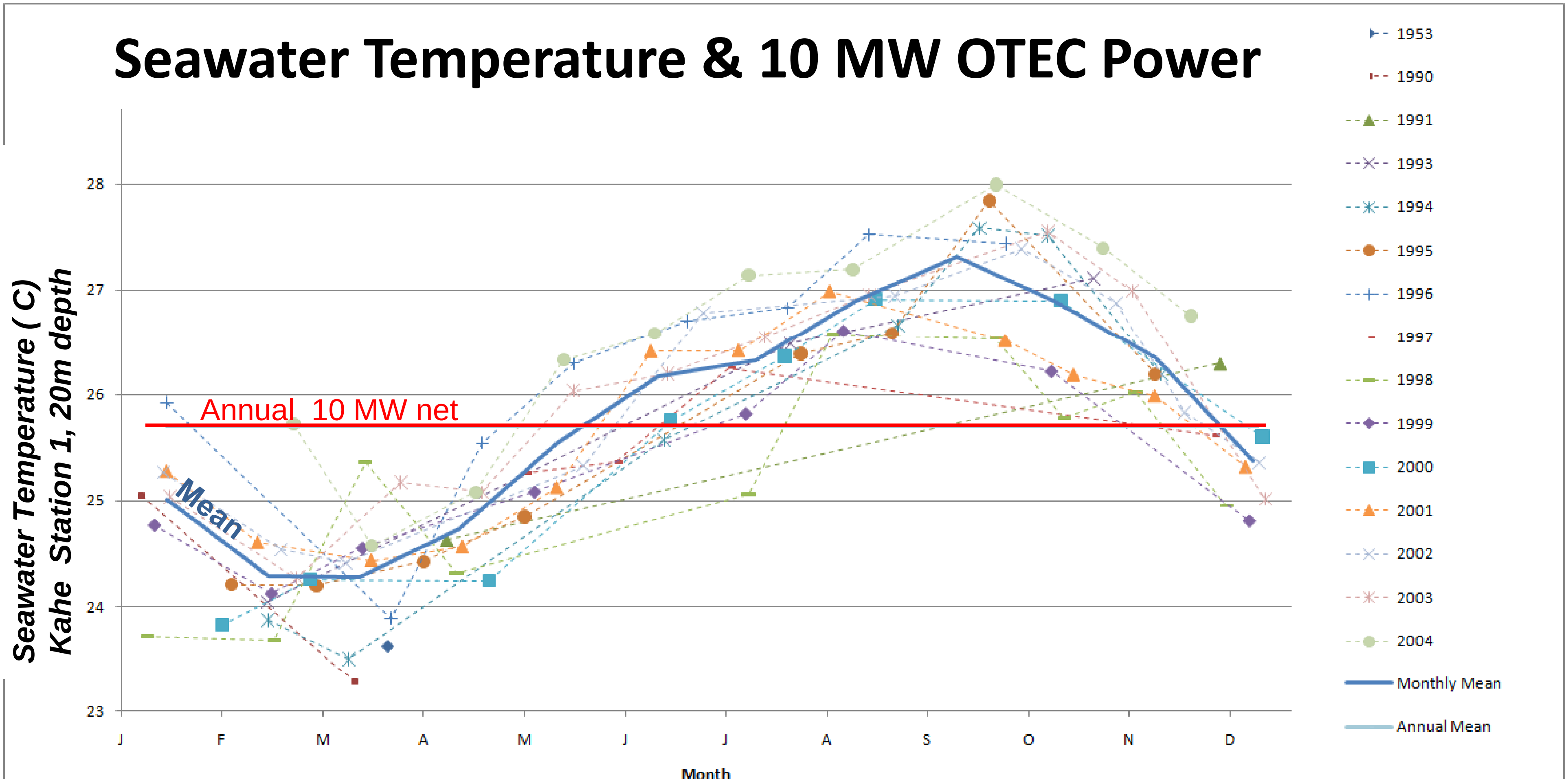


Table calculated by Makai Thermo-Economic OTEC Model

Case	WW Temp [C]	CW Temp [C]	SW dT [C]	Gross Power [MW]	Net Power [MW]
Avg + 2SD Summer	28.2	3.86	24.3	18.11	13.51
Avg +1SD Summer	27.6	3.86	23.7	17.29	12.72
Average Summer	27.0	4.11	22.9	16.17	11.65
Baseline	25.7	4.11	21.6	14.44	10.00
Average Winter	24.4	4.11	20.3	12.70	8.34
Avg -2SD Winter	23.1	4.35	18.8	10.75	6.47

Summer

Mean

Winter

Gross Power vs Net Power

- **Gross** Power 14.44 MW =>Avg. **Net** Power: 10 MW
- Key Parasitic Loads
  - CW Pumps: 2.24 MW
  - WW Pumps: 1.31 MW
  - Ammonia Pumping: 0.18 MW
  - Topsides Load: 0.4 MW

Typical Component Efficiencies

- Turbo-generator: 80%
- Power Cable: 97%
- Seawater Pumps: 75%
- Power Cable: Variable 94%-97%
- Transformers: Variable 98%-99%

10 MWnet Pilot Plant

14.4 MWgross power

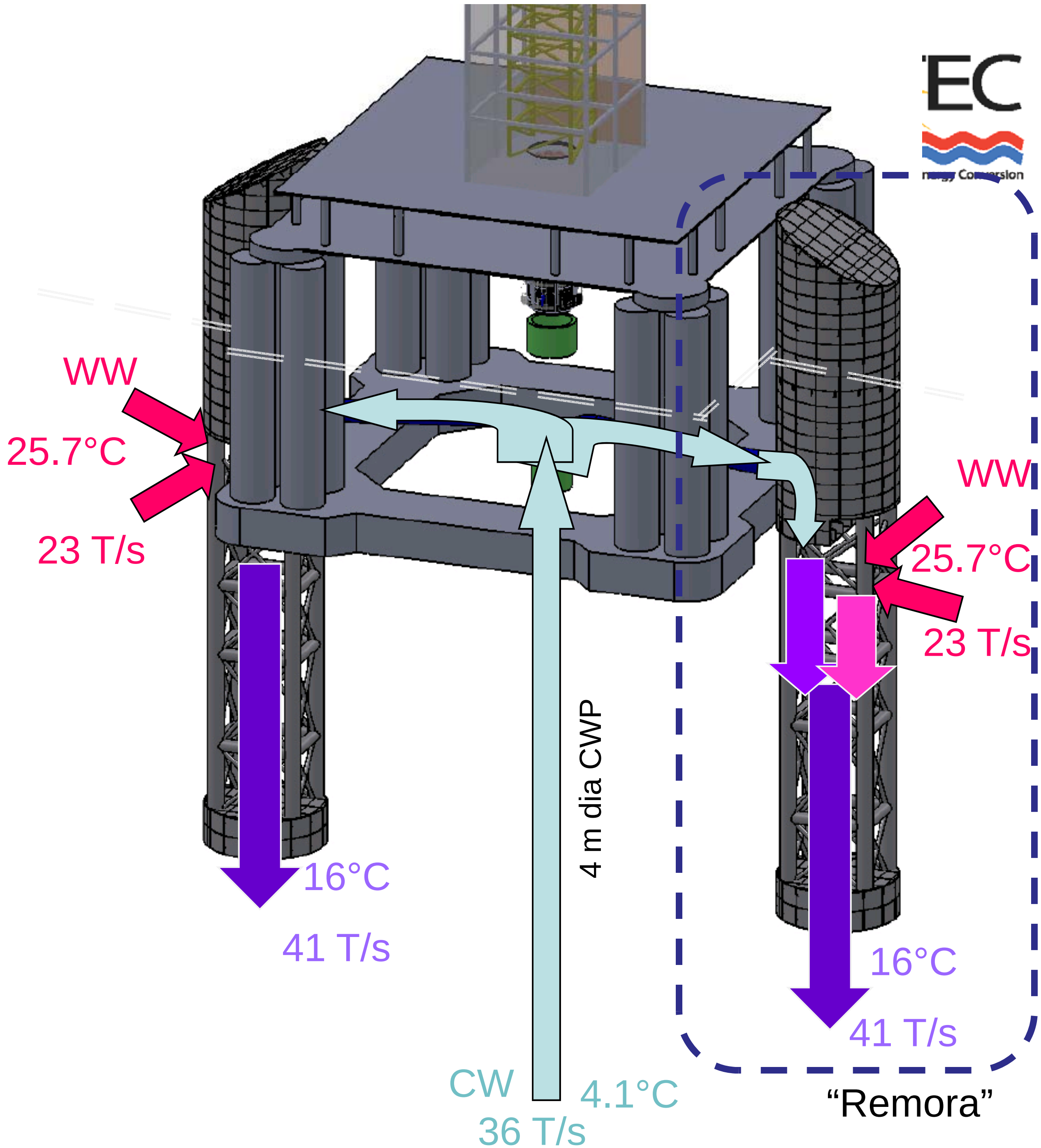
WW inlet at 20m deep

Screen velocity = 0.15m/s

CW intake at 1000m deep, ~100m above seabed

CWP velocity = 2.5m/s

Two discharges at 70 – 90m (TBR) depth with 1 m/s downward velocity



Flow Summary
100 MWnet

~140 MWgross power

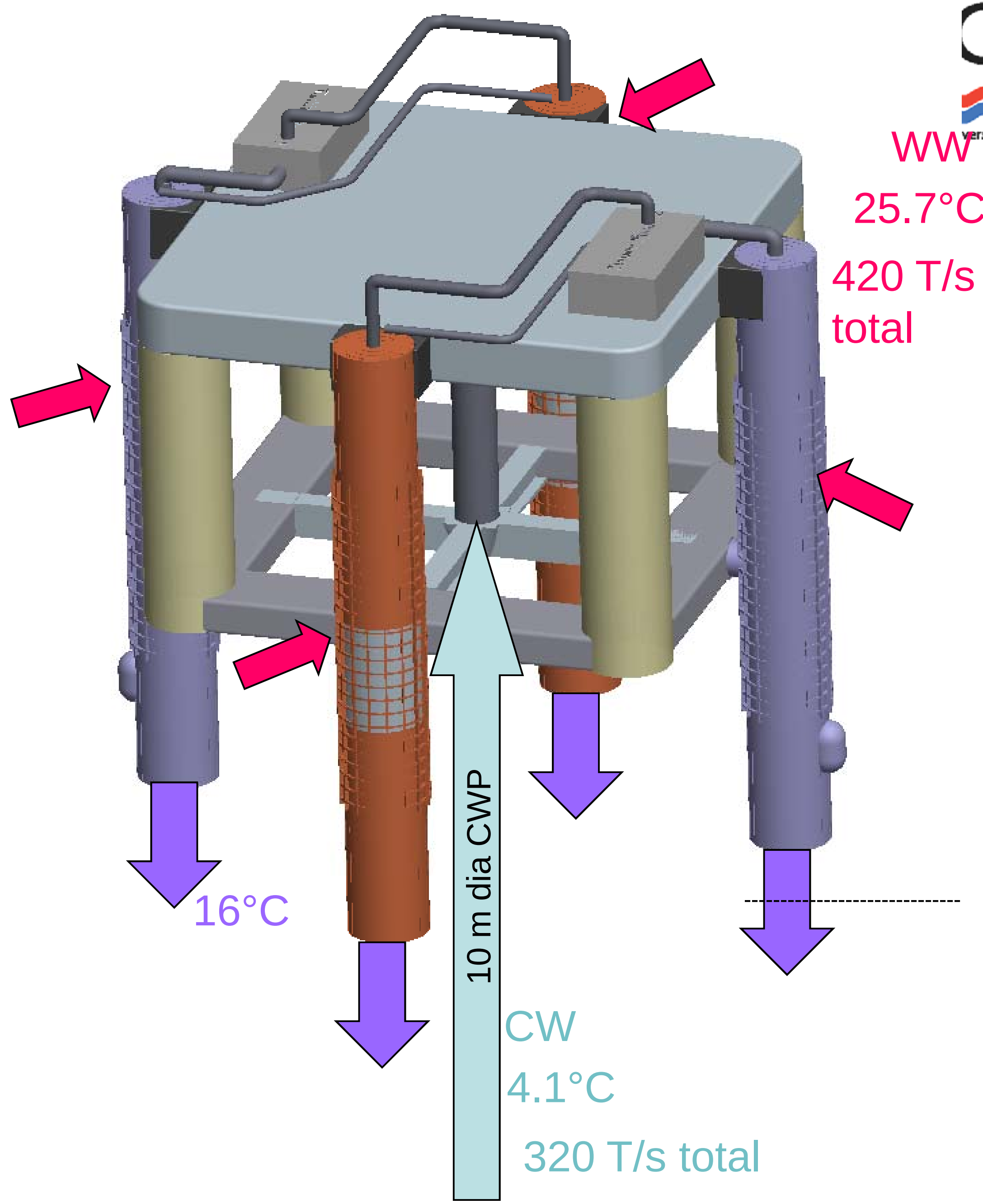
WW inlet at 20-30m deep

Screen velocity = 0.15m/s

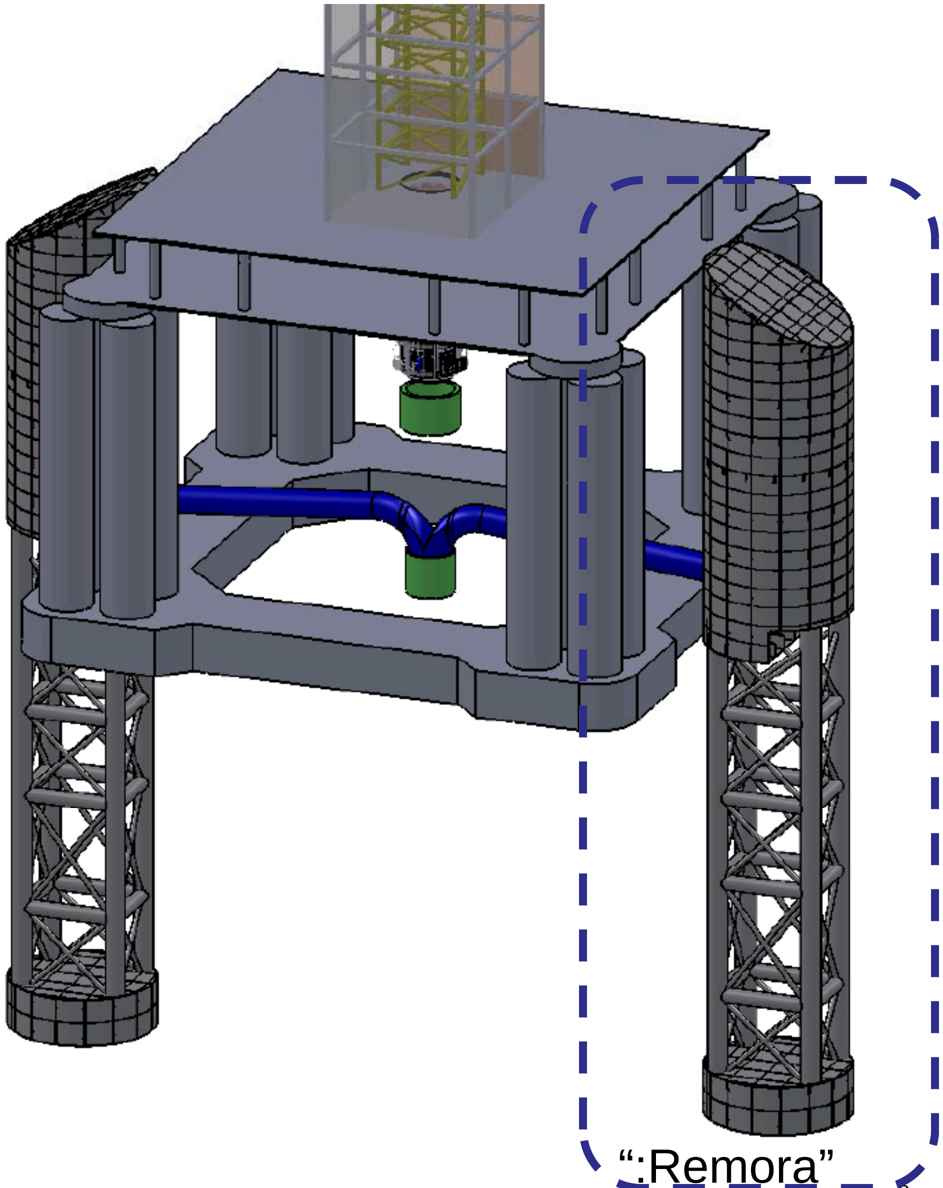
CW intake at 1000 - 1200m deep

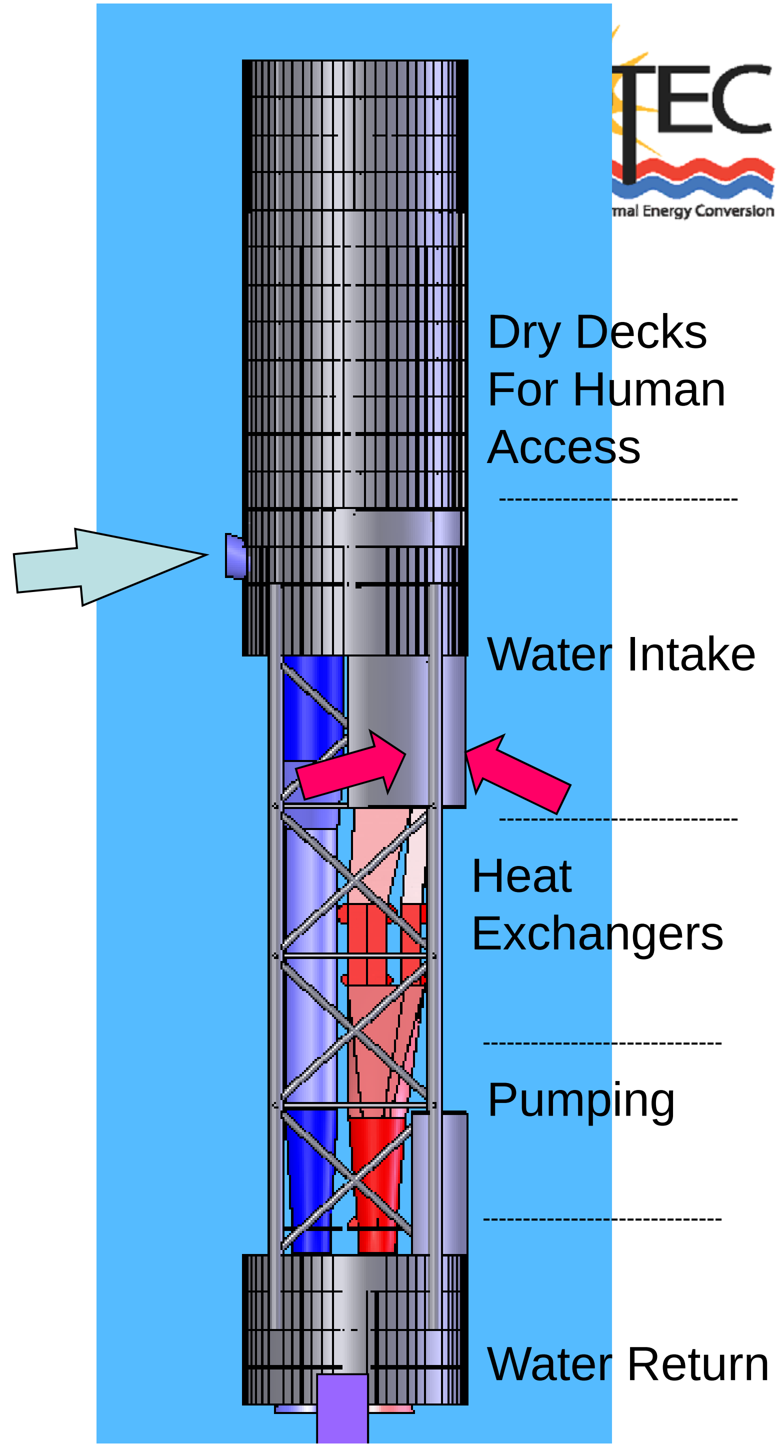
Intake ~100m above seabed

Discharges at 70 – 90m (TBR) depth



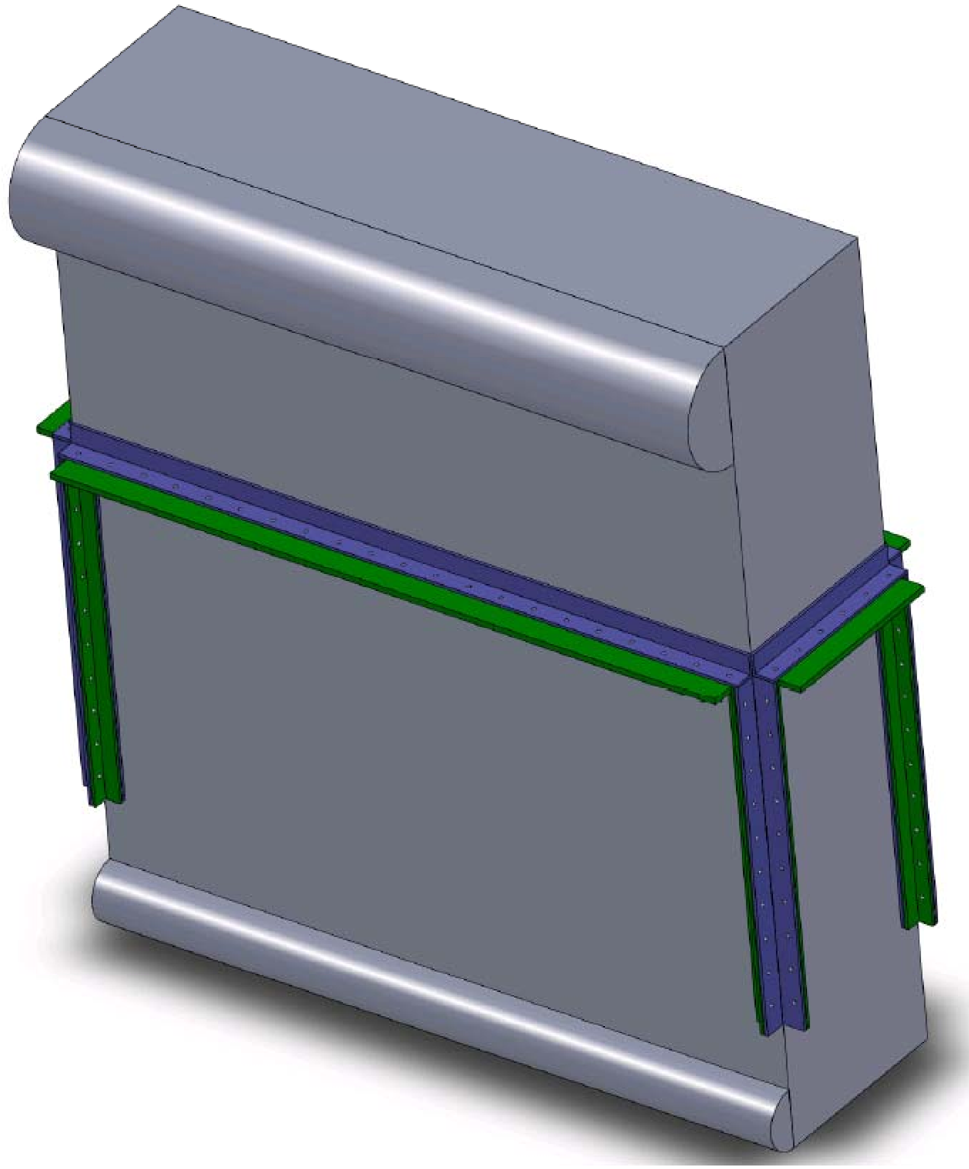
What’s in a Remora?





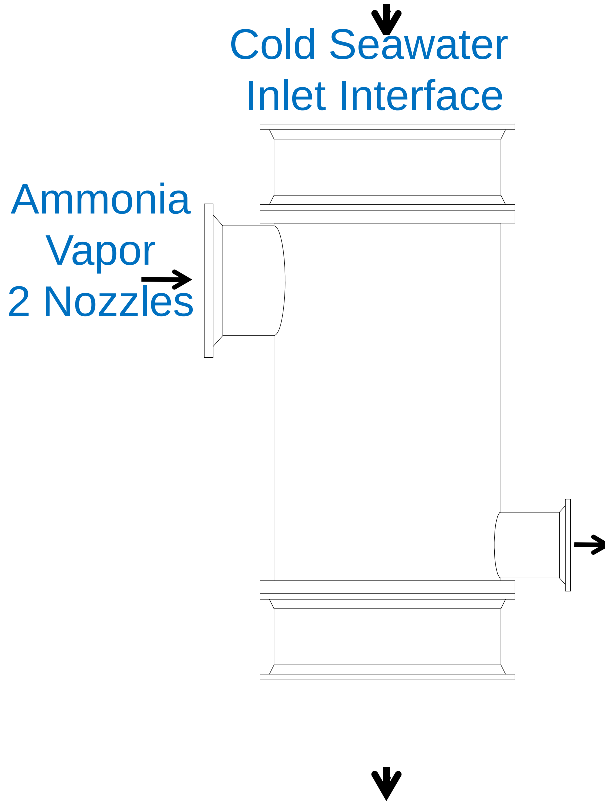
Evaporators

- 6 identical "batteries" per Remora
- A3003 brazed aluminum
- Biofouling controlled via hypochlorite treatment
  - Periodic – 1 hour per day
  - Concentration – 70ppb
- Water Flow: 23 tonne/s
- Heat Transfer area: 17111 m^2



Condensers

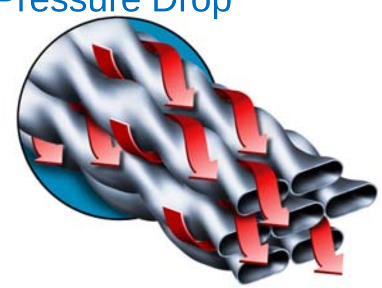
Two 4.3m dia x 7m tall Shell & Tube HX per Remora



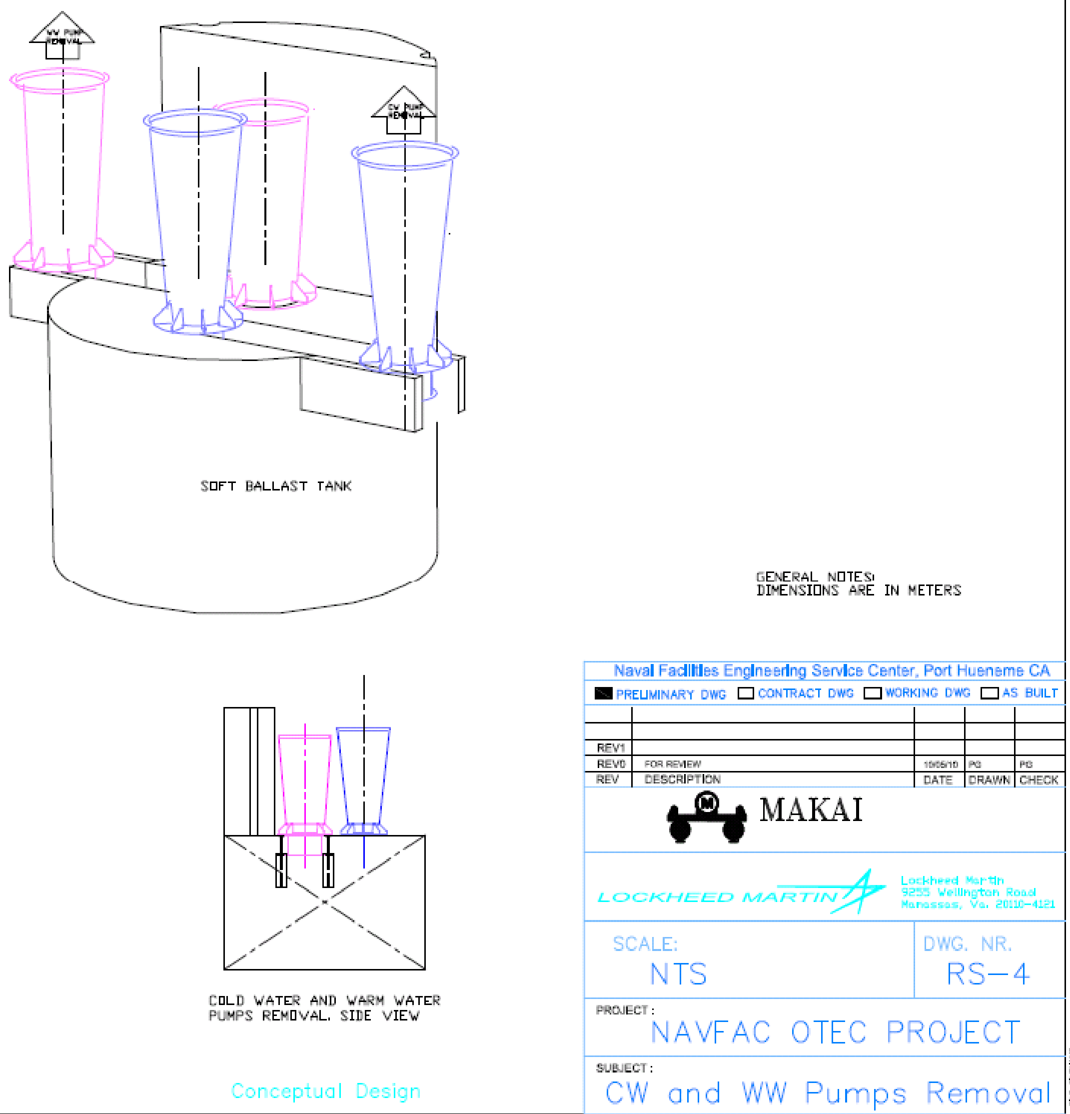
Material: Titanium (pending more corrosion test data for Al alloys)
Form Factor: Enhanced Tubes (either twisted or spirally indented)
Heat Transfer Area: 22407 m2
Water Flow: 18.3 tonne/s
Biofouling control: N/A

Tube support baffles are not required, making compact design

Swirling Flow Enhances Heat Transfer Coefficient on Both Sides without Corresponding Increase in Pressure Drop

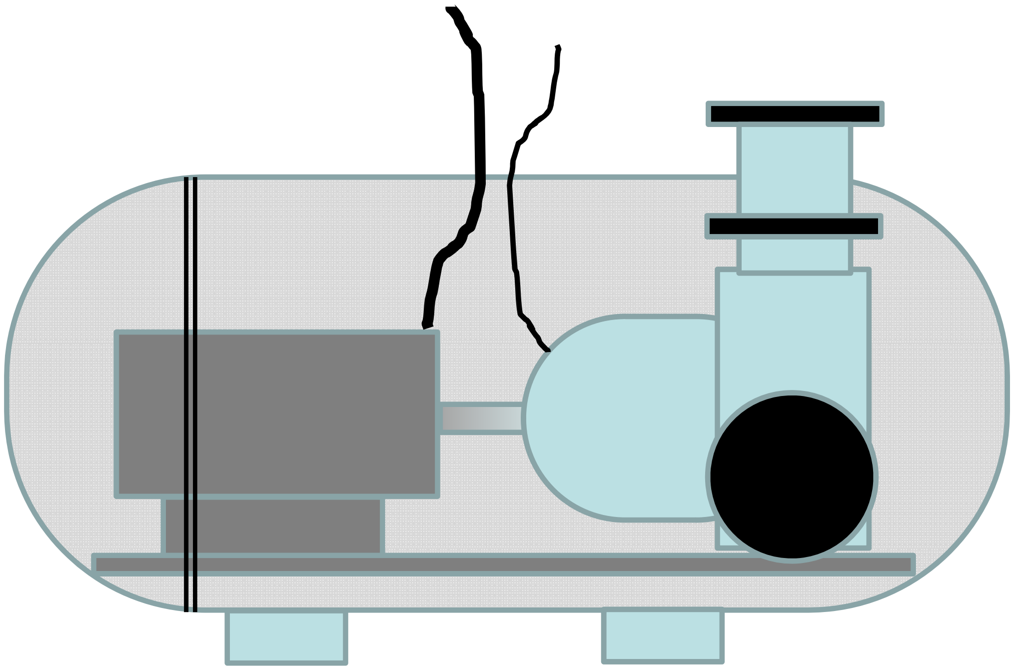


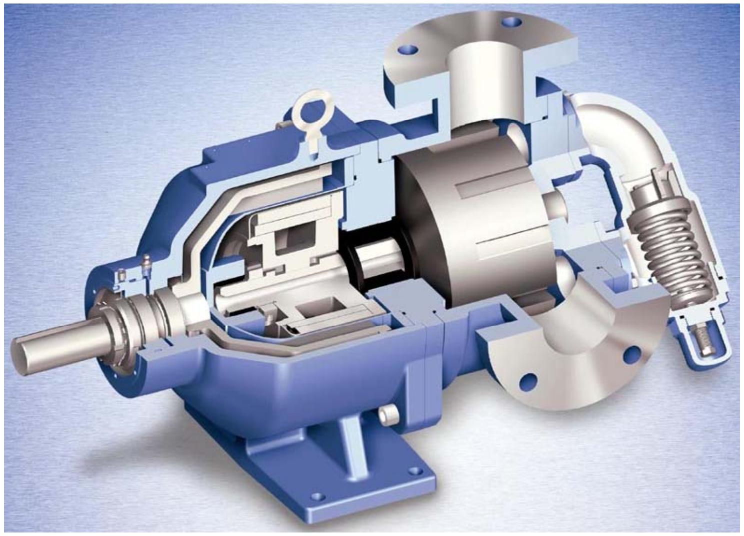
Seawater Pumps



Ammonia System

- Minimal valves in seawater
- Redundant pumps within sealed pods
- Full system “charge” approximately 16,000 gallons (10MW plant) NH3





Platform: Moored Platform Installed Using ABS and/or DNV Standards