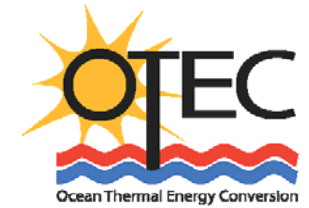


# OTEC Overview



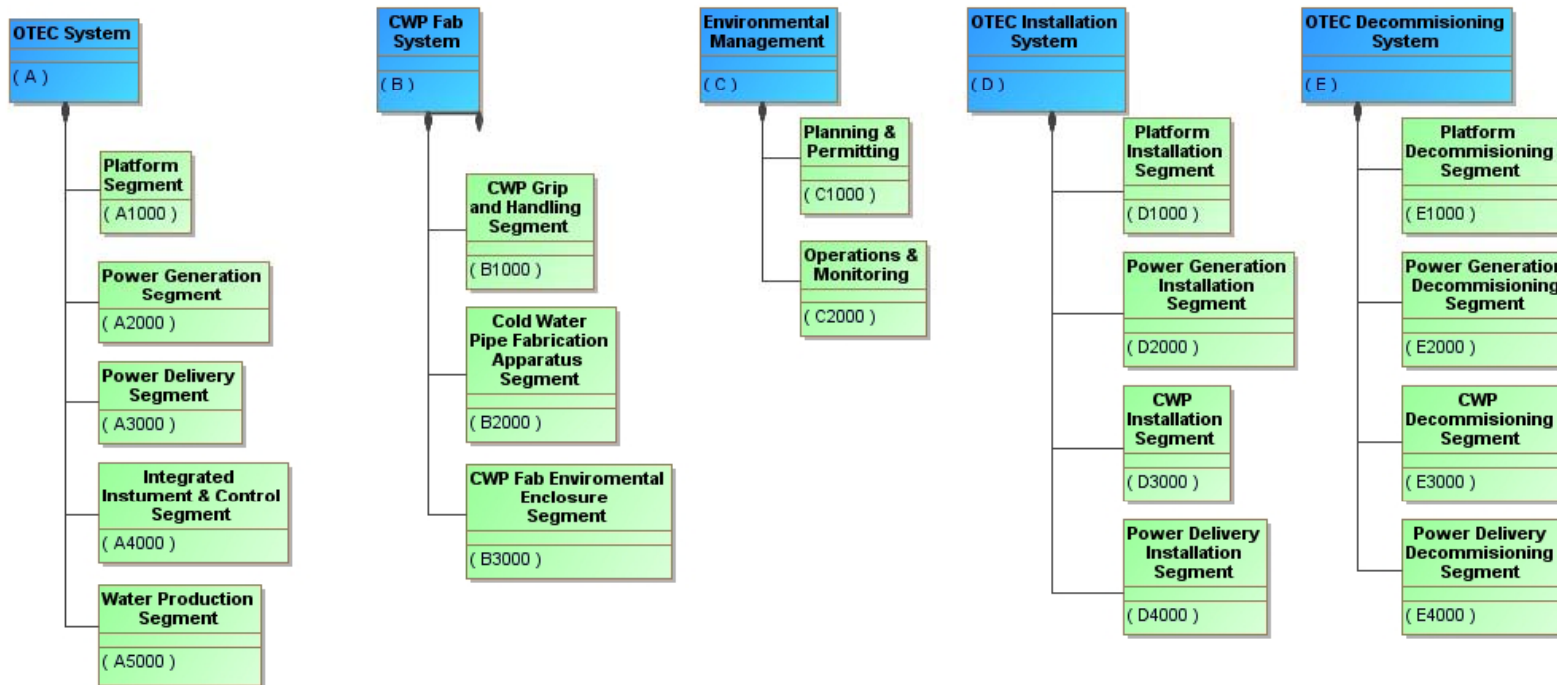
**Workshop on Ocean Thermal Energy Conversion (OTEC):  
Assessing Potential Physical, Chemical and Biological Impacts  
and Risks**

***June 22, 2010***

# Anatomy of an OTEC System

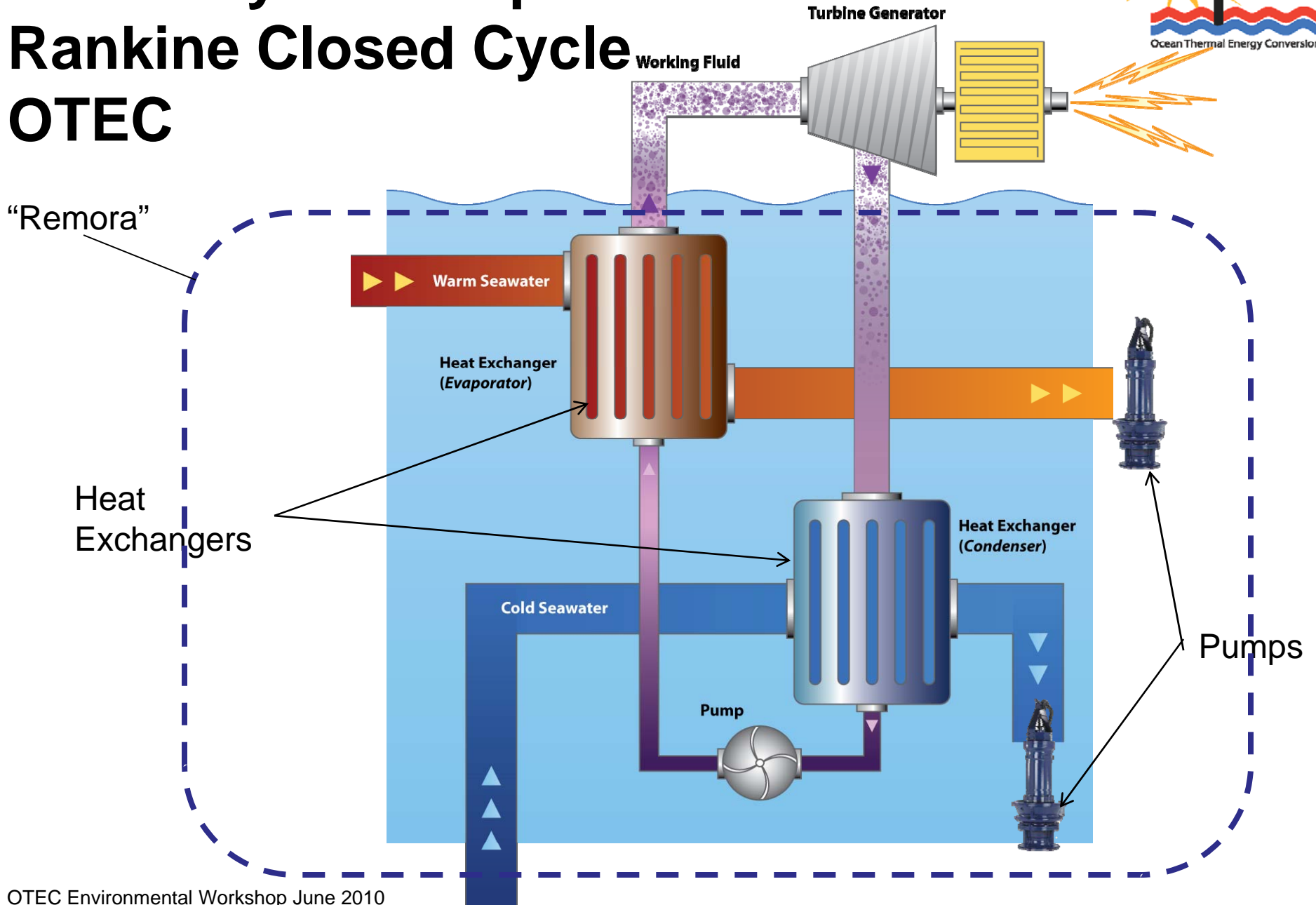
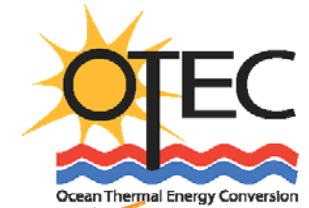


package Data [ OTEC Program System Architecture ]



Rev 5  
2 June 2010

# Power Cycle: Simple Rankine Closed Cycle OTEC



# Seawater Temperature & 10 MW OTEC Power

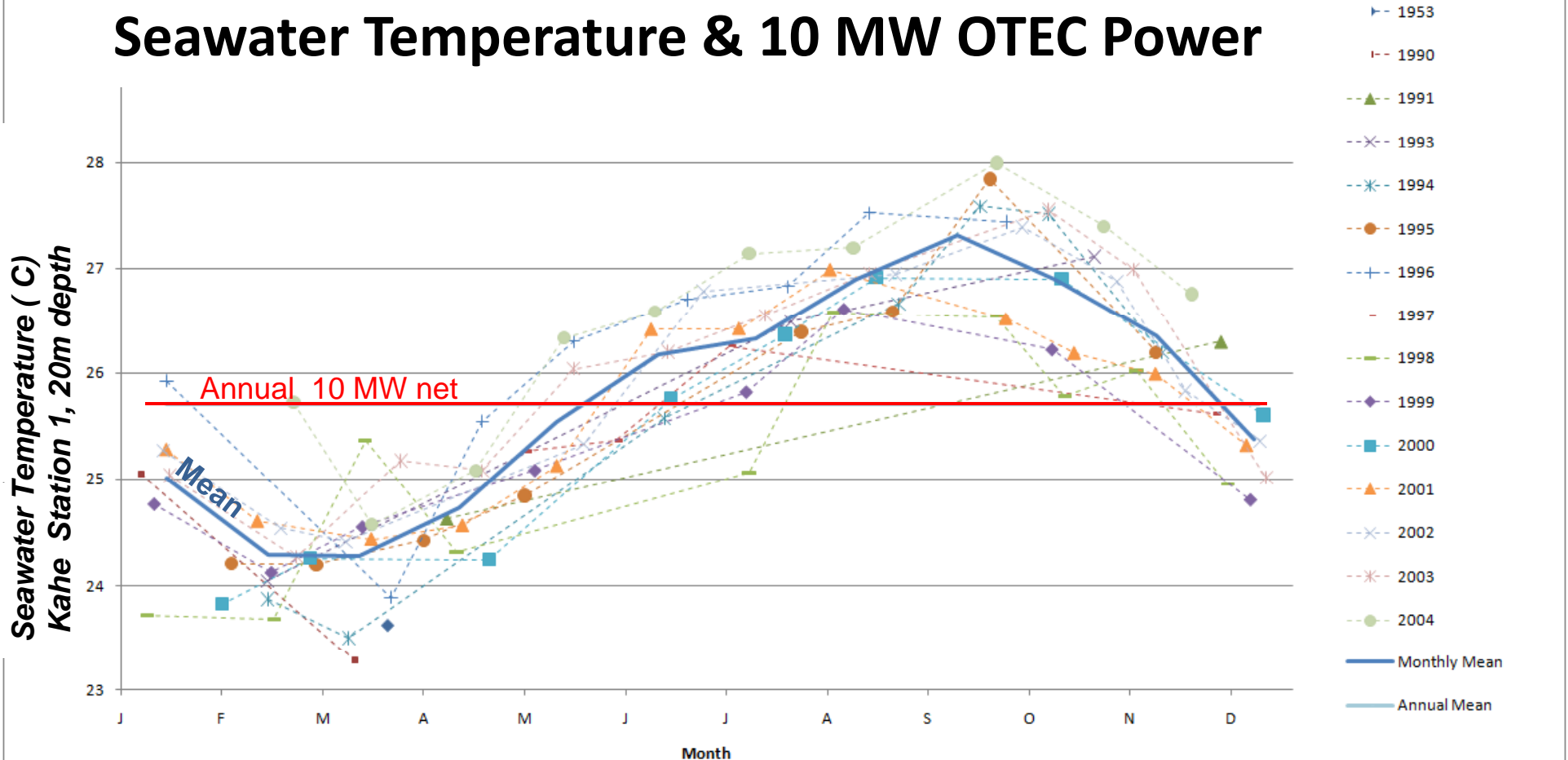
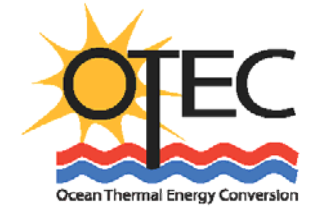


Table calculated by Makai Thermo-Economic OTEC Model

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



# ***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 MW<sub>net</sub> Pilot Plant

14.4 MW<sub>gross</sub> power

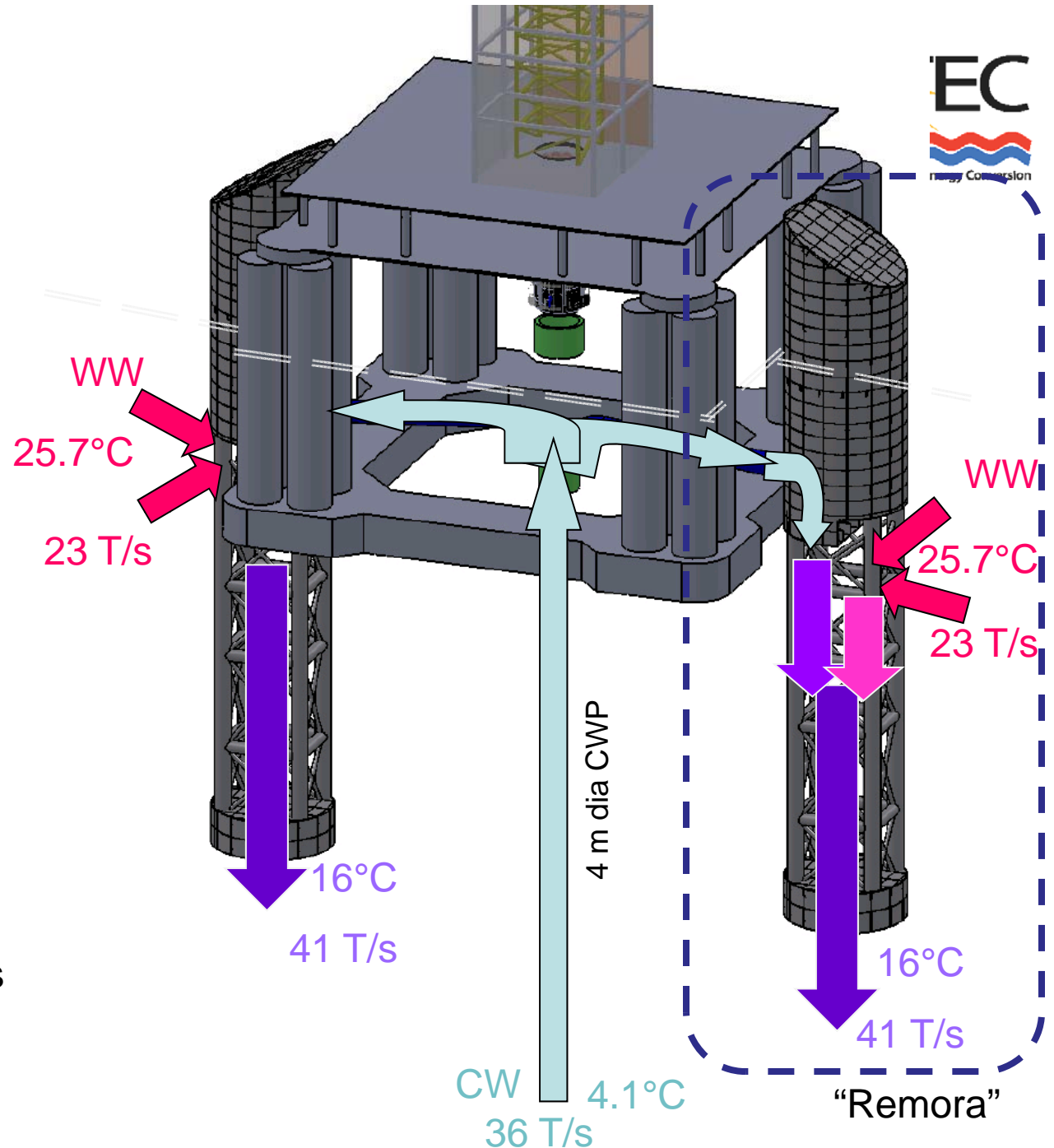
WW inlet at 20m deep

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 MW<sub>net</sub>

~140 MW<sub>gross</sub> power

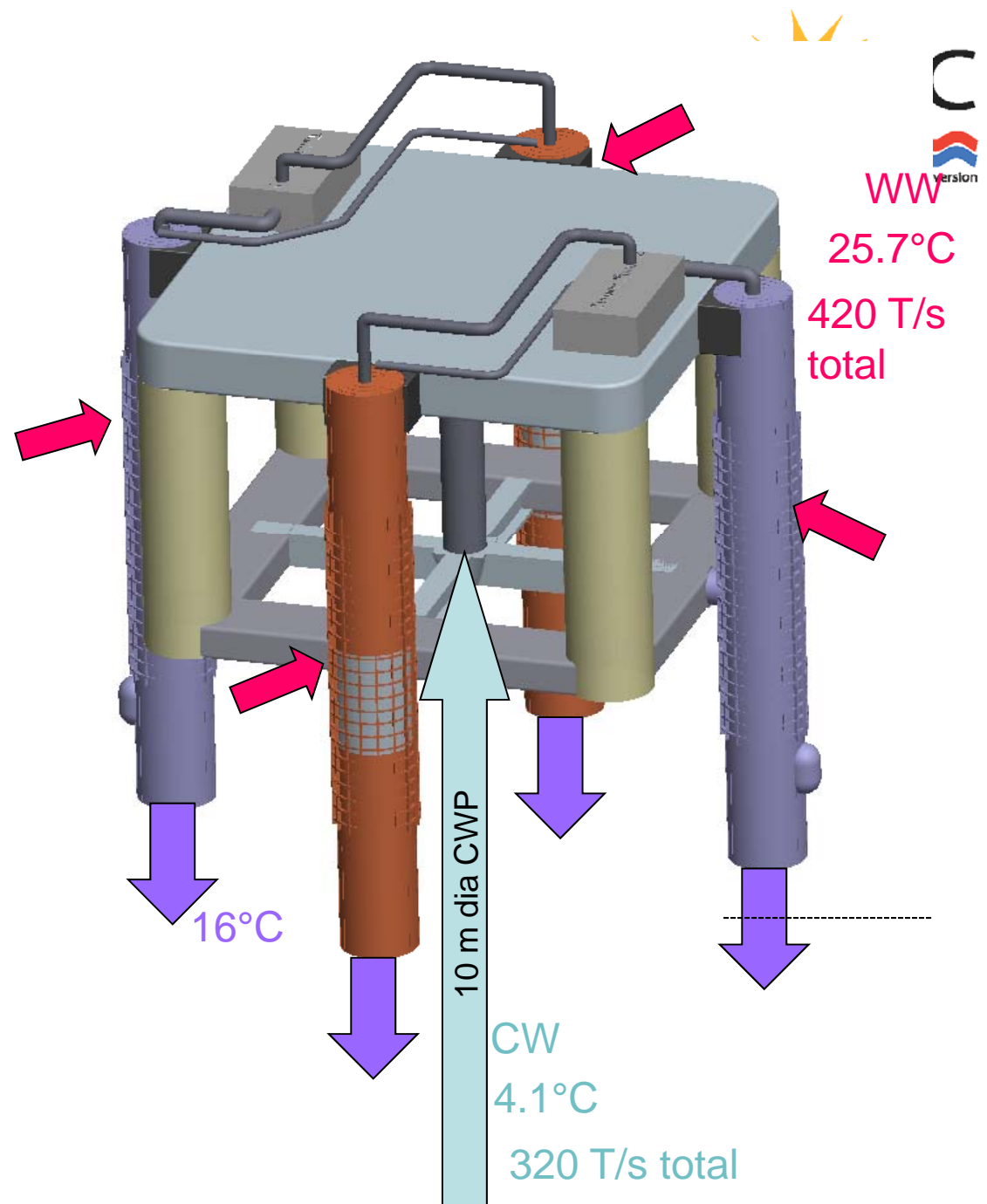
WW inlet at 20-30m deep

Screen velocity = 0.15m/s

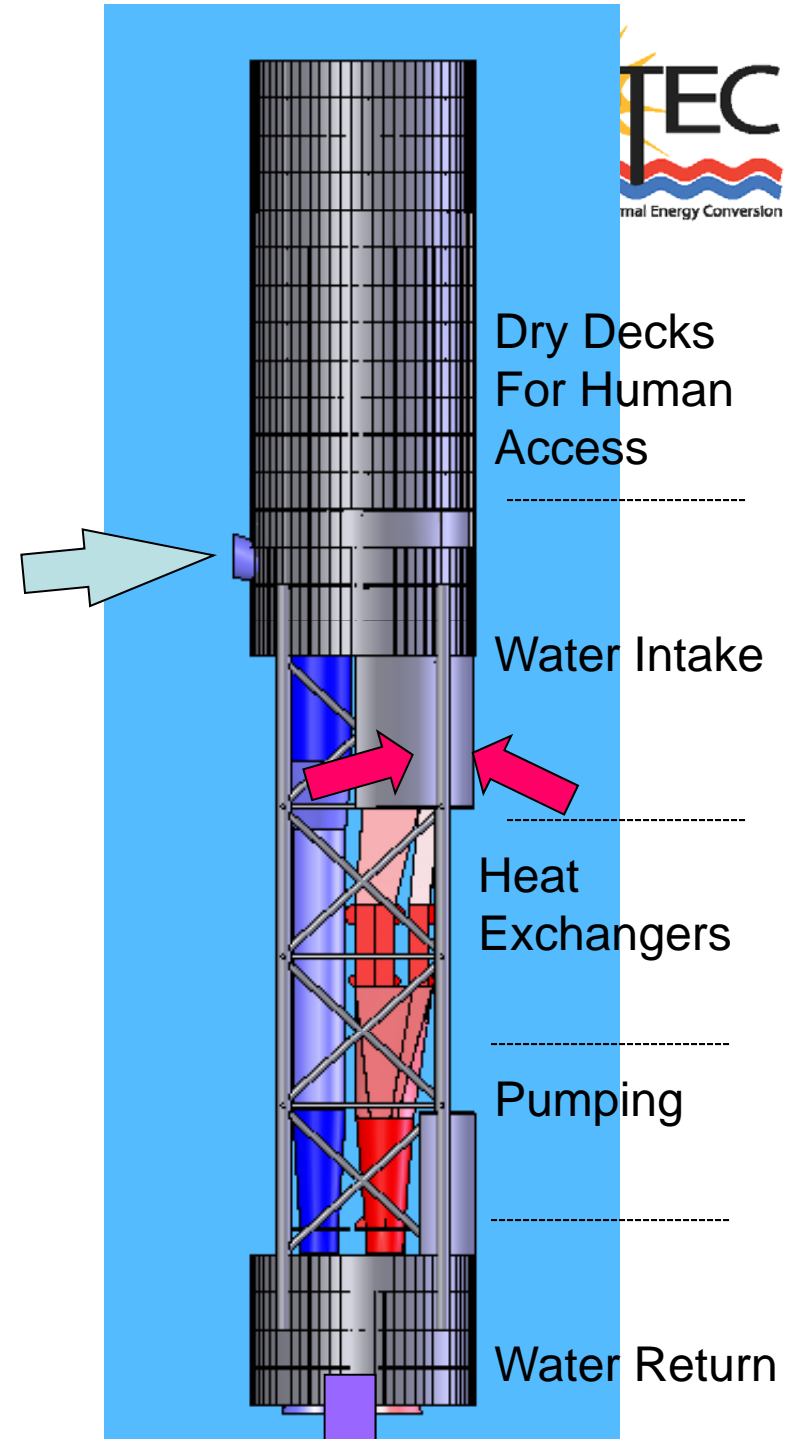
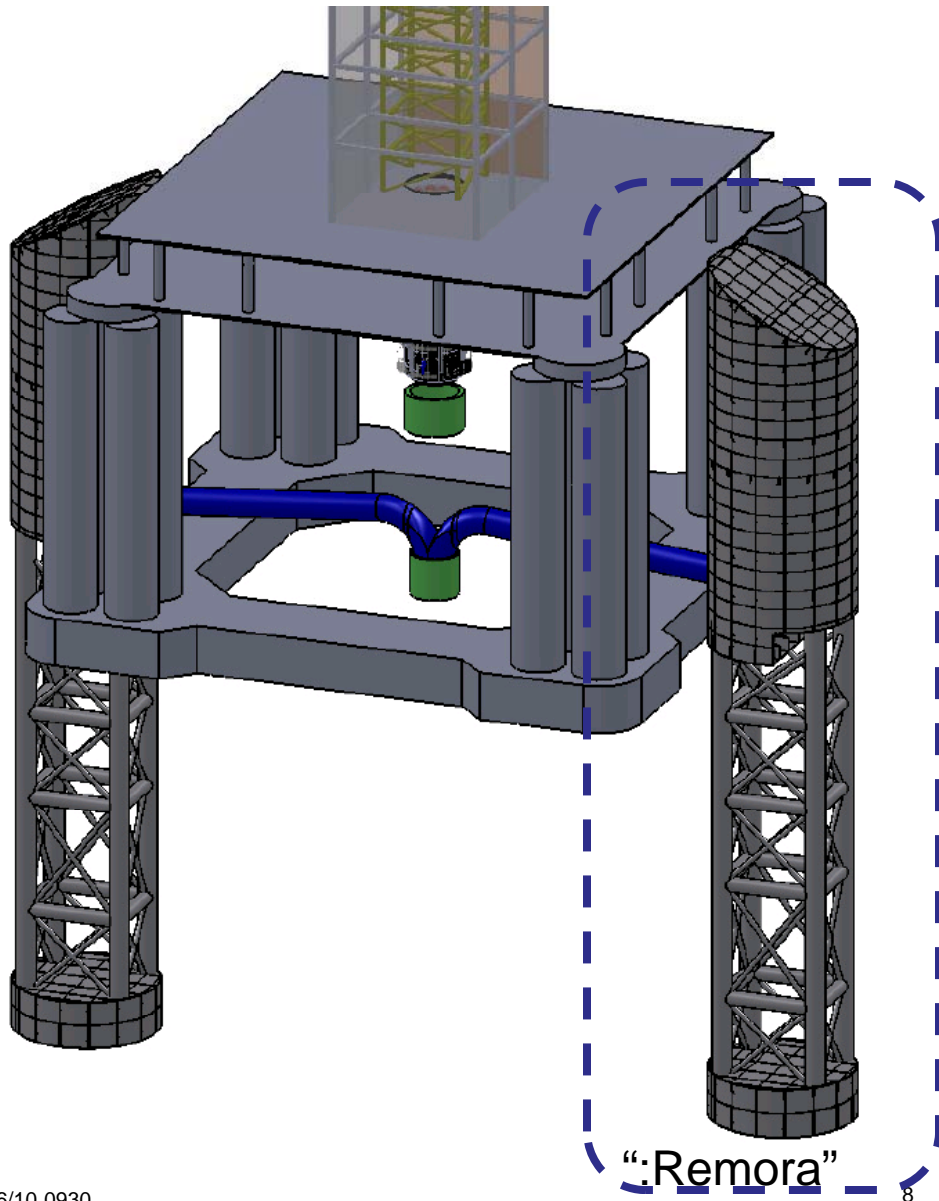
CW intake at 1000 - 1200m deep

Intake ~100m above seabed

Discharges at 70 – 90m (TBR) depth

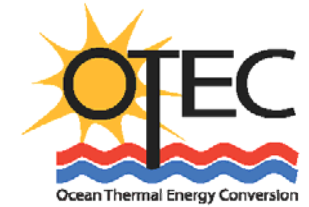


# What's in a Remora?

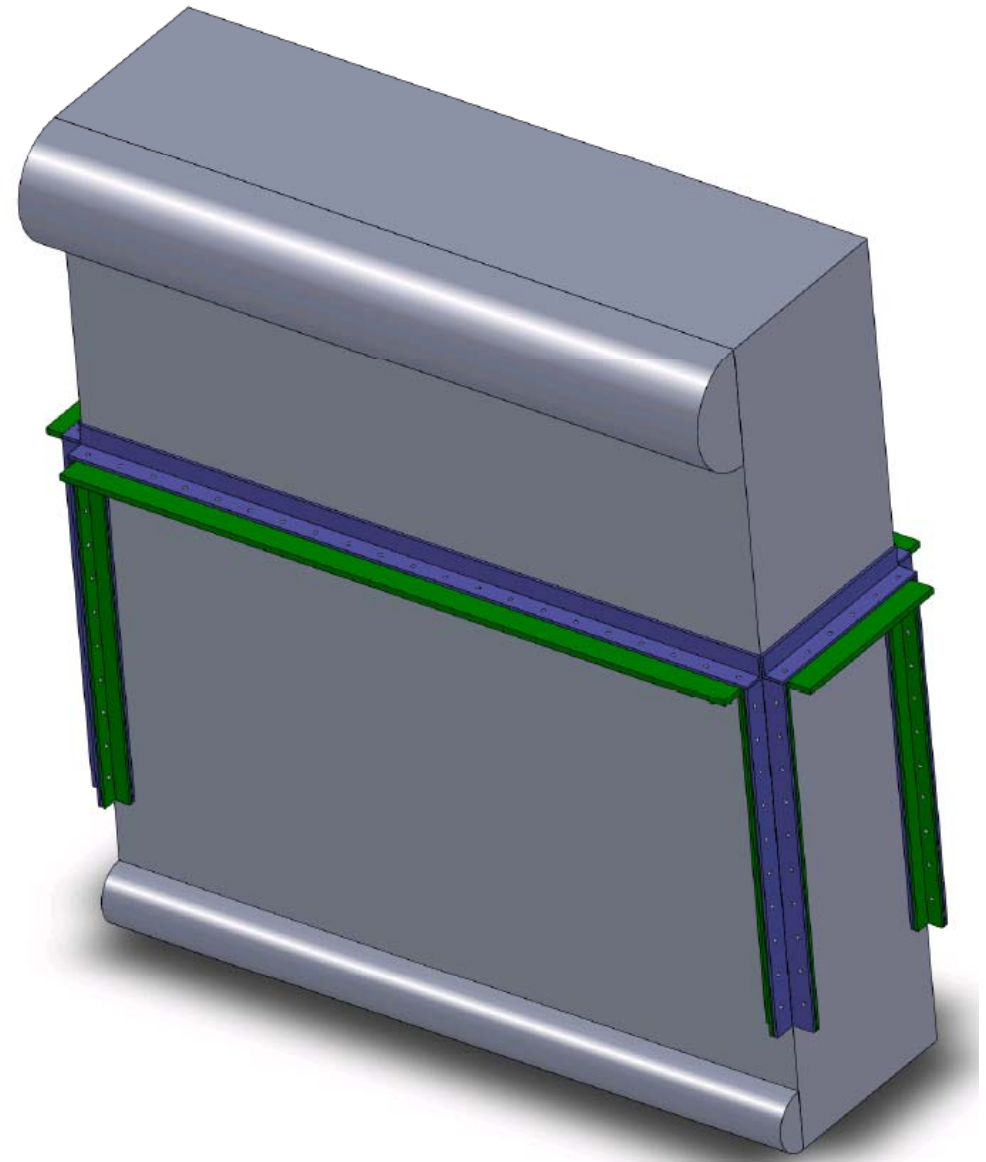




# Evaporators

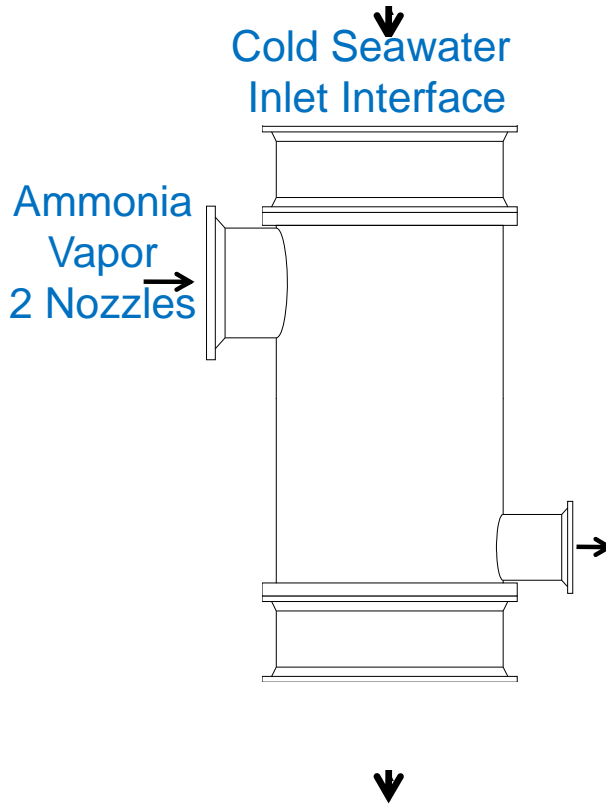
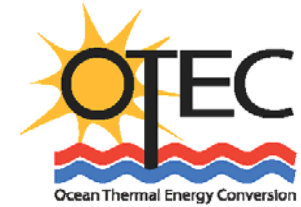


- 6 identical “batteries” per Remora
- A3003 brazed aluminum
- Biofouling controlled via hypochlorite treatment
  - Periodic – 1 hour per day
  - Concentration – 70ppb
- Water Flow: 23 tonne/s
- Heat Transfer area: 17111 m<sup>2</sup>



# 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)

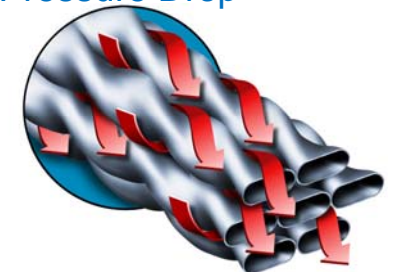
**Heat Transfer Area:** 22407 m<sup>2</sup>

**Water Flow:** 18.3 tonne/s

**Biofouling control:** N/A

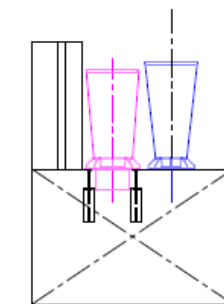
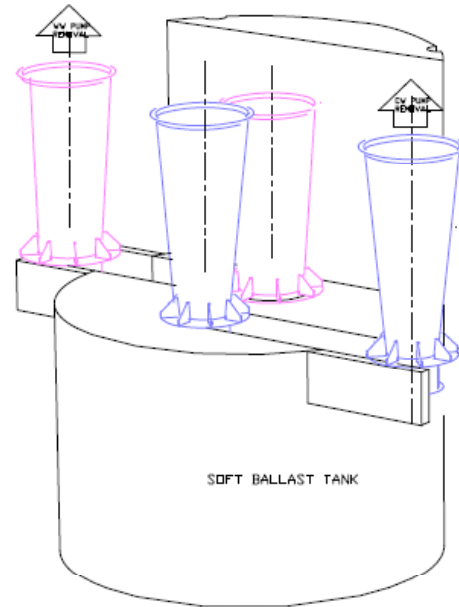


Swirling Flow Enhances Heat Transfer Coefficient on Both Sides without Corresponding Increase in Pressure Drop



Tube support baffles are not required, making compact design

# Seawater Pumps



COLD WATER AND WARM WATER PUMPS REMOVAL, SIDE VIEW

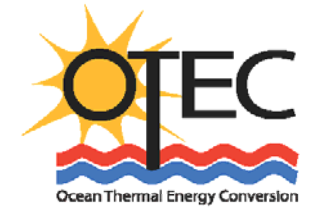
Conceptual Design

GENERAL NOTES:  
DIMENSIONS ARE IN METERS

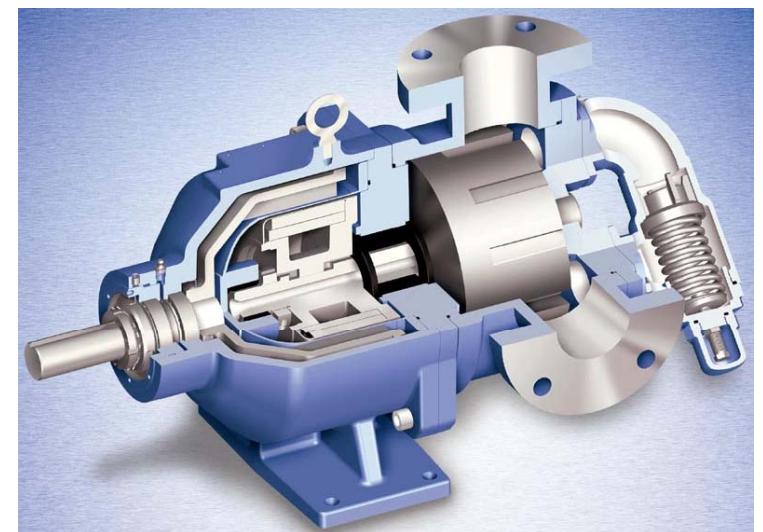
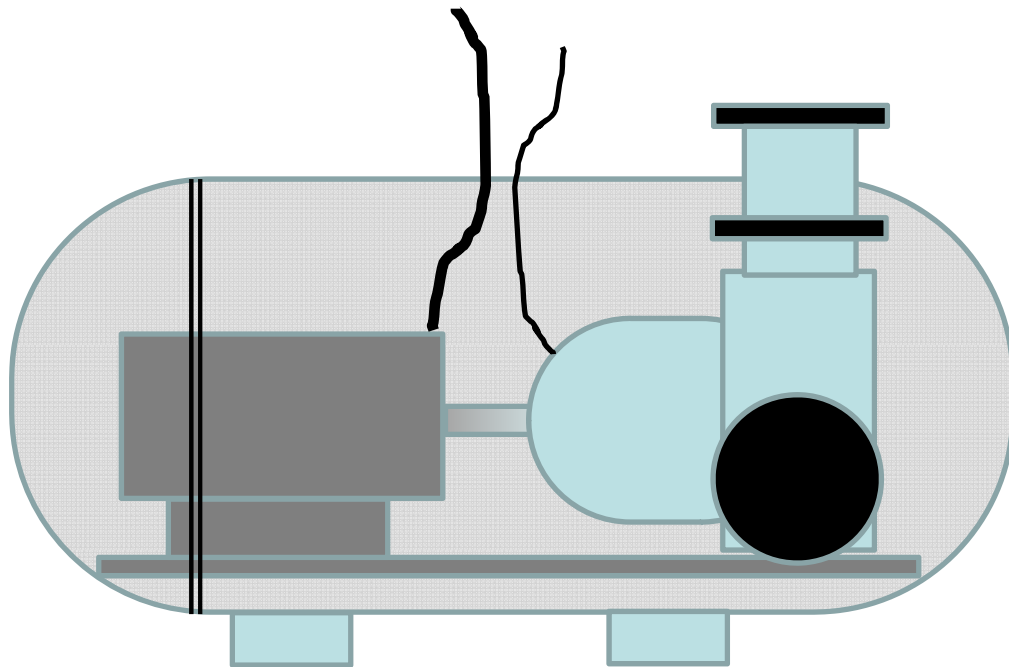
Naval Facilities Engineering Service Center, Port Huensame CA			
<input checked="" type="checkbox"/> PRELIMINARY DWG <input type="checkbox"/> CONTRACT DWG <input type="checkbox"/> WORKING DWG <input type="checkbox"/> AS BUILT			
REV1			
REV0	FOR REVIEW	10/05/10	IP0 PG
REV	DESCRIPTION	DATE	DRAWN CHECK
		Lockheed Martin 9225 Wellington Road Manassas, Va. 20108-4121	
SCALE: NTS		DWG. NR. RS-4	
PROJECT: NAVFAC OTEC PROJECT			
SUBJECT: CW and WW Pumps Removal			

THIS IS A PRELIMINARY DRAWING

# Ammonia System



- Minimal valves in seawater
- Redundant pumps within sealed pods
- Full system “charge” approximately 16,000 gallons (10MW plant) NH<sub>3</sub>



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

