The Air is Getting Cleaner!

2007 Cleanest Yet!

Southland Ozone Trends, 1976-2007

PM2.5 Average Concentrations

*2007 data preliminary, through Oct. 1
Long-Term Emissions Trends in the US

 Dieselpm

 baseline – absent new standards

 L & M = 45%

PM (tons)

Calendar Year

On-Highway

Nonroad

Locomotive and Marine

...?
Diesel PM from Goods Movement

2005
- Trucks*: 53 tons/day
- Ships
- Locomotives
- Harbor Craft
- Cargo Equipment

2020
- Trucks*: 36 tons/day
- Ships
- Locomotives
- Harbor Craft
- Cargo Equipment

* Includes TRUs
Throughput vs Emissions

Throughput up 44%

2001 vs. 2005

Vessel Emissions

PM10

NOx

SOx

12%

-6%

-4%
Container Ship Evolution

1st Generation (Pre-1960 - 1970)
- TEU Capacity: 1,700 TEU

- TEU Capacity: 2,305 TEU

3rd Generation (1985)
- TEU Capacity: 3,220 TEU

- TEU Capacity: 4,848 TEU

5th Generation (2000 - ?)
- TEU Capacity: 7,598 TEU
Ship Emissions are a World Wide Issue
IMO
MARPOL 73/78, Annex VI

Entered into Force May 19, 2005*
- Establish Ship Engine NOx Standard
- Sets a Cap on Fuel Sulfur Content
- Limits Ozone Depleting Chemicals
- Provides for Sulfur Emission Control Areas (SECAs)

*Limited in Scope, still not adopted by the U.S.A. Needs to be more stringent and comprehensive
The SECA Boundaries

- East of 5 W
- East of 4 W
- South of 62 N
- 57.44.08 N
- Mongstad
- Bergen
- Falmouth
- Baltic Sea
- North Sea
Amendments to Annex VI

NOx Engine Standards

- Tier 1 – 17.0 g-NOx/kW-hr, vessels 1990 - 2010
- Tier 2 – 14.4 g-NOx/kW-hr January 1, 2011
- Tier 3 – 3.4 g-NOx/kW-hr January 1, 2016

In ECA, Tier 2 outside ECA

Global Sulfur Cap

- 4.5% reduced to 3.5% in 2012
- 0.5% as early as 2020 but no later than 2025*
  * fuel availability study 2018.

SECAs to ECAs

- 1.5% sulfur reduced to 1.0% on March 1, 2010
- 0.1% on January 1, 2015
CARB Auxiliary Engine Fuel Regulation

Switch to distillate fuels 24 nm offshore
- 2007
  - Marine Gas Oil
  - Marine Diesel Oil < 0.5% Sulfur
  - Alternative Compliance Plans*
- 2010
  - Distillate fuel < 0.1% Sulfur
  - Fuel availability review?

PMSA Litigation Stops CARB Enforcement

* New Version – Fuel Only, Avoids Waiver
Switch to distillate fuels 24 nm offshore
- July 1, 2009
  - 1.5% S Marine Gas Oil (MGO)
  - 0.5% S Marine Diesel Oil (MDO)
  - Alternative Compliance Plans
- January 1, 2012
  - Distillate fuel between 0.1% & 0.2% Sulfur
  - Fuel availability review?

Workshop – May 13, 2008
Approval – July 25, 2008?
Ports’ Clean Fuel Incentive Program

- 100% of Cost between Residual Fuel and 0.2% Sulfur MGO (LA Index)
- 1yr. July ’08 – July ’09 (CARB Reg.)
- Ship Registration Required (May ’08)
- Requires VSR and LSF in Auxiliaries
- $9.9 Million - POLB, $8.6 million – POLA
Low Sulfur Marine Fuels

- Cost
- Availability
- GHG Penalty
IMO Green House Gas Considerations (MEPC 58)

**Short Term**
- Global Levy Scheme
- Improvement of Fuel Consumption
- Energy Efficiency Design and Management Plan
- Onshore Power
- Wind Power
- Voluntary/Mandatory CO₂ reporting, information exchange, performance ratings
- Strict limitation on refrigerant gas leakage
- Vessel Speed Reductions
- Improved Traffic Control, Fleet Management, Cargo Handling Operations
IMO Green House Gas Considerations (MEPC 58)

**Longer Term**

- Technical Measures for Ship Design
- Use of Alternative Fuels
- CO₂ Design Index for New Ships
- Verification Scheme for CO₂ Operational Index
- Non-compliance penalty mechanism
- Emission Trading Scheme
- Mandatory CO₂ Index for Port Infrastructure
- Other Measures Developed by the GHG Working Group (Oslo June 2008)
AB32
California Global Warming Solutions Act

Goal 1990 levels by 2020
est. 173 MMT CO₂

Goods Movement = 3%

2004 Emissions (480 MMT CO₂E)
- Transportation: 38%
- Industrial: 20%
- Residential: 6%
- Electricity Generation (In State): 12%
- Electricity Generation (Imports): 13%
- Commercial: 3%
- Agriculture: 6%
- Harbor Craft: 8%

Total Emissions: 14.7 MMT CO₂
AB32 Vessel Measures

- Shore Power (0.24 MMT CO₂)
- Vessels Speed Reduction (1.4 MMT CO₂)
- Vessel Operation Best Practices (1.6 MMT CO₂)
  - Engine Maintenance
  - Optimized Propeller/Hull Designs
  - Advance Hull Coatings & Maintenance
  - Air Cavity System
  - Sails
  - Advanced Heat Recovery
  - Alternative/Renewable Fuels
  - Route Planning/Vessel Speed Reductions
Ship Emission Control

- IMO & U.S. Engine Stds.
- Vessel Speed Reduction
- Cleaner Fuels
- Engine Technology
- Retrofits
COLD IRONING

CARB Regulation, Dec ‘07
- Percent Calls & Emission Goals (80% 2020)
Voluntary Vessel Speed Reduction Program/Reg?

$V = E^3$

Initiated May 2001
Green Flag Program
+ 90% compliance
MAN Diesel Engine Technology (NOx)

Electronic Controls -30%
Slide Valves -30%
Water Emulsification -30%
Scavenge Air Moistening -50%
Selective Catalytic Red. -98%
Sea Water Scrubbing (SOx & PM)

Sea water is pumped to the scrubber. CaCO3 absorbs the SOx from the exhaust. Produces CaSO4 in discharge.

Scrubber also removes most of the particulates. PM is removed from the discharge and disposed at dock.
Water In Fuel Emulsification

- Water content of 10-20% tested
- NOx reduction = water content
  20% water = 20% less NOx
- PM reduction is 2-3 times % of water
  20% water = 60% less PM
Wittmar Non-Grid Cold Ironing

- Depending on the Length of Stay and Hotelling kW load, the Air Pollution Reduced by using Wittmar DFMV™
  - NOx - is Reduced 98%
  - CO - is Reduced 57%
  - PM10 - is Reduced 99%
  - SOx - is Reduced 100%
  - CO2 - is Reduced 57%
Advanced Maritime Emissions Control System (AMECS)
Fuel Saving Strategies

AIR CAVITY SYSTEM

Compressor
Air Cavity
Air deflection before propeller

Compressor
Air Cavity

SkySails

Images of ships and sails
Concept Vessel of the Future

• Solar
• Wind
• Wave
• Fuel Cells
Thank you!
Questions?