Mitigating the Effects of Port Operations on Climate Change

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AB32
California Global Warming Solutions Act

Goal 1990 levels by 2020
est. 173 MMT CO₂

2004 Emissions (480 MMT CO₂E)

- Transportation: 38%
- Residential: 6%
- Industrial: 20%
- Agriculture: 5%
- Commercial: 3%
- Electricity Generation (Imports): 13%
- Electricity Generation (In State): 12%

Goods Movement = 3%
CARB Cargo Handling Equipment Regulation

Pre-2003 – 50% in 2007
2003-2007 phased over 8 to 11 years
2007+ 100% in 2008 Tier 4 goal

*One year extensions given for on-road engines and verified retrofits
Non-Yard Tractors Cargo Handling Equipment

Retrofit or Replace*
25% increments

- 2007 – pre-’88
- 2008 – ’88-’95
- 2009 – ’96-’02
- 2010 – ’03-’06
- 2012 – Tier 4

*Equipment not capable of retrofit must be replaced by 2015
Cargo Handling Equipment

Propane

LNG

Electric

RMGs
Regen.
Flywheels
Advanced Terminal Design
Advanced Terminal Design
Ship Emissions are a World Wide Issue
Diesel PM from Goods Movement

- Ships: 53 tons/day
- Trucks: 36 tons/day

*Includes TRUs*
Throughput vs Emissions

Throughput up 44%

Vessel Emissions
Container Ship Evolution

1st Generation     (Pre-1960 - 1970) - 1,700 TEU
2nd Generation    (1970 - 1980) - 2,305 TEU
3rd Generation     (1985) - 3,220 TEU
4th Generation     (1986 - 2000) - 4,848 TEU
5th Generation     (2000 - ?) - 7,598 TEU
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.
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 Fuel Sulfur Regulation

Auxiliary, Main Engines & Auxiliary Boilers

Switch to distillate fuels 24 @ nm
- July 1, 2009
  - 1.5% S Marine Gas Oil (MGO)
  - 0.5% S Marine Diesel Oil (MDO)
  - NO Alternative Compliance Plans
- January 1, 2012
  - Distillate fuel between 0.1% & 0.2% Sulfur
  - Exemptions for Innocent Passage, Safety, Essential Modification
  - Non-compliance fees, $45,500 - $227,500
Low Sulfur Marine Fuels

- Cost
- Availability
- GHG Penalty
Ports’ Clean Fuel Incentive

- 100% of Cost between Residual Fuel and 0.2% Sulfur MGO (LA Index)
- 1yr. July ’08 – July ’09 (CARB Reg.)
- $9.9 Million - POLB, $8.6 million – POLA
- Requires VSR and LSF in Auxiliaries
- 160 Ships Registered-350 calls/quarter
- PMSA Members ~ 80% participation
IMO Green House Gas Considerations (MEPC 58/60)

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 58/60)

Longer Term

• Technical Measures for Ship Design
• Use of Alternative Fuels
• CO$_2$ Design Index for New Ships
• Verification Scheme for CO$_2$ Operational Index
• Non-compliance penalty mechanism
• Emission Trading Scheme
• Mandatory CO$_2$ Index for Port Infrastructure
• Other Measures Developed by the GHG Working Group (Oslo June 2008)
GHG Emission Reduction Proposals

- **Germany**
  - Ports Collect, Based on Fuel Consumed
  - Ships Specific Accounts
  - IMO Creates Cap, Auctions Allowances, Disperses funds

- **Norway**
  - IMO Sets Cap based on Existing Carbon Markets
  - Administers Revenue for Marine Technology, Credits, Developing Countries

- **Denmark**
  - Fuel Bunker Levy to International funds
  - International Agency Uses Funds in Developing Countries or IMO Technical Corporate Program

- **United States**
  - Performance Based Vessel Standards, Ship Specific Management Plan
  - Consistent with Emission Based Approach of Annex VI
AB32 Vessel Measures

- Shore Power (0.24 MMT CO\(_2\))
- Vessels Speed Reduction (1.4 MMT CO\(_2\))
- Vessel Operation Best Practices (1.6 MMT CO\(_2\))
  - 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
COLD IRONING

CARB Regulation, Dec ‘07
- Percent Calls & Emission Goals (80% 2020)
Clean Air Logix
Non-Grid Cold Ironing

On-Dock Transformer & Synchronization
Bow thruster interface

LNG Genset
1 Megawatt
Voluntary Vessel Speed Reduction Program/Reg?

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%
Exhaust Gas Recirc. (EGR) -60%
Selective Catalytic Reduction -98%
Fuel Saving Strategies
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
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.
Advanced Maritime Emissions Control System (AMECS)
Concept Vessel of the Future

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