Questions or Comments???

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Overview

Cargo Handling Equipment (CHE)
CHE includes any motorized vehicles used to handle cargo or perform routine maintenance activities and can be a significant source of diesel PM emissions in communities near the ports and intermodal rail facilities.

Ocean-Going Vessels (OGV)
OGV are large vessels designed for deep water navigation and are a significant part of California’s trade economy. OGVs are expected to be one of the largest sources of emissions in the near future, being a significant source of GHG emissions, criteria pollutants, and toxic air contaminants near ports and marine terminals.
Growing Importance of Marine Emissions

Statewide Mobile NOx Emissions by Source (Baseline)

Source: CEPAM 2019 Summer emissions; OGVs includes emissions up to 100 nautical miles
Cargo Handling Equipment (CHE)

Background and Major Updates
What is Cargo Handling Equipment (CHE)

- Mobile cargo handling equipment is any motorized vehicle used to handle cargo or perform routine maintenance activities at California’s ports and intermodal rail yards.

- CHE has an impact on air quality in communities near the ports.
What is an Emissions Inventory?

An emissions inventory for an industry sector accounts for:

- **Population** of equipment
- How often it is used (**activity**)
- The equipment **model year** (newer equipment is generally cleaner)
- The region where the equipment is used (generally by **county**)
- The total resulting **emissions** from the equipment

CARB uses emissions inventories to understand where air pollution comes from and to create strategies for emission reductions.
Data Sources

• **Port Emissions Inventories Data:**
  • Port of Los Angeles, Port of Long Beach, Port of Oakland

• **CARB reporting data:**
  • **Ports:** Bay Area Bulk Terminal, Concord Naval Weapons Station, LA Berth 240, Port of Hueneme, Port of Redwood City, Port of Richmond, Port of Sacramento, Port of San Diego, Port of San Francisco, Port of Stockton

  • **Rail Yards:** UPRR City of Industry, UPRR Commerce, UPRR ICTF, UPRR LATC, UPRR Lathrop, UPRR Oakland, BNSF Commerce, BNSF Los Angeles (Hobart), BNSF North Bay Intermodal Yard, BNSF Oakland, BNSF San Bernardino, BNSF Stockton
Statewide CHE Populations

Fuel Type

Total Population Count vs. Fuel Type

- Diesel: 3500
- Propane: 600
- Electric: 300
- Gasoline: 100
- LNG: 10

CARB
Statewide CHE Population

Total Population: 4,764

Note: Rubber-tiered Gantry Crane (RTG), Automated Guided Vehicles (AGV), Ship-to-Shore Crane (STS)
Statewide Electric Equipment

Total Population Count

- Crane: 171
- AGV: 72
- STS Crane: 72
- Forklift: 24
- Truck: 7
- Lift: 7
- Tractors/Loaders/Backhoes: 2
- Electric Pallet Jack: 2
- Other: 2
- Container Handling Equipment: 1

Automated Guided Vehicles (AGV), Ship-to-Shore Crane (STS)
Population Comparison by Model Year

Total Population Count

- Previous Model
- Draft Updates

Emission Factors

- Using latest emission factors for diesel, propane, and gasoline off-road equipment
- Using EMFAC2021 rates for on-road yard trucks
- May be further updated with CHE-specific emission factors in next iteration
Load Factors

- Load factors are the same as the 2011 model and consistent with San Pedro Bay Ports emissions inventories.
- Based on CHE operations data from 2007.
- Load factors for yard tractors and RTG cranes are based on 2006 and 2009 studies by Starcrest.
- Average of 1-4 day period over the span of a month.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Load Factor</th>
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<tbody>
<tr>
<td>AGV</td>
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<tr>
<td>Compactor</td>
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<tr>
<td>Container Handling Equipment</td>
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<tr>
<td>Crane</td>
<td>0.43</td>
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<tr>
<td>Electric Pallet Jack</td>
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<tr>
<td>Excavator</td>
<td>0.55</td>
</tr>
<tr>
<td>Forklift</td>
<td>0.30</td>
</tr>
<tr>
<td>Lift</td>
<td>0.51</td>
</tr>
<tr>
<td>Other</td>
<td>0.51</td>
</tr>
<tr>
<td>Rail Car Mover</td>
<td>0.51</td>
</tr>
<tr>
<td>RTG Crane</td>
<td>0.20</td>
</tr>
<tr>
<td>Skid Steer Loaders</td>
<td>0.55</td>
</tr>
<tr>
<td>STS Crane</td>
<td>0.43</td>
</tr>
<tr>
<td>Tractor</td>
<td>0.55</td>
</tr>
<tr>
<td>Loaders/Backhoes</td>
<td>0.55</td>
</tr>
<tr>
<td>Truck</td>
<td>0.51</td>
</tr>
<tr>
<td>Yard Truck</td>
<td>0.39</td>
</tr>
</tbody>
</table>
Cargo Handling Equipment (CHE)

Growth Rates
Port of Oakland

- Using 2019 Tioga Report prepared for Bay Conservation and Development Condition, focused specifically on Port of Oakland

Percent Year Over Year Growth

An Alternative option to adjust for COVID related impacts
Ports of Los Angeles and Long Beach

- Using Mercator slow-growth assessment, following discussions with ports and South Coast AQMD

An Alternative option to adjust for COVID related impacts
Smaller Ports Based on Region

- Using Freight Analysis Framework (FAF) low growth scenario for remaining areas

![Graph showing percent year over year growth for different regions over the years 2020 to 2050. The graph compares Rest of CA, Sacramento CA, San Diego CA, and San Francisco CA.]
Rail Yards

• Using Freight Analysis Framework (FAF) growth scenario for railyard growth
Cargo Handling Equipment (CHE)

Emissions Results
Statewide CHE Population

- Total Population Count
- Year
- 2010 On Road
- Pre-2010 On Road
- Propane
- Gasoline
- Electric
- Diesel Tier 4
- Diesel Tier 4i
- Diesel Tier 3
- Diesel Tier 2
- Diesel Tier 1
- Diesel Tier 0
- Prior Inventory

CARB
Statewide NOx

- Total NOx, tpd
- Year
- 2010 On Road
- Propane
- Pre-2010 On Road
- Gasoline
- Electric
- Diesel Tier 4
- Diesel Tier 4i
- Diesel Tier 3
- Diesel Tier 2
- Diesel Tier 1
- Diesel Tier 0
- Prior Inventory
Statewide PM 2.5

[Graph showing the trend of PM 2.5 emissions from various sources over years]

- 2010 On Road
- Pre-2010 On Road
- Propane
- Gasoline
- Electric
- Diesel Tier 4
- Diesel Tier 4i
- Diesel Tier 3
- Diesel Tier 2
- Diesel Tier 1
- Diesel Tier 0
- Prior Inventory
2019 Population by Fuel Type

No significant electric penetration in top 3 categories

- Propane
- LNG
- Gasoline
- Electric
- Diesel

Yard Truck, Forklift, RTG Crane, Crane, Truck, Lift, STS Crane, AGV, Rail Car Mover, Tractor, Excavator, Other, Electric Pallet Jack, Compactor (Portable)
Voluntary Electrification - POLA

Equipment by Fuel Type

Electric

Total Population Count

Year


Total Population Count

Year


Diesel
Gasoline
Propane
LNG
Electric
Voluntary Electrification - POLB

Equipment by Fuel Type

- Diesel
- Gasoline
- Propane
- Electric

Year: 2015, 2016, 2017, 2018, 2019

Total Population Count

Electric

Year: 2015, 2016, 2017, 2018, 2019

Total Population Count
CHE Inventory Summary

• Electrification not broadly expanding without requirements

• Gasoline, Propane, Electric, LNG equipment is included in the inventory update

• Ports have older equipment inventory than predicted, fewer Tier 4 final and 2010+ on-road engines
What Are Your Thoughts

• **Electrification Trends:** There is no obvious trend for increased electrification of Cargo Handling Equipment (CHE) in California. Are there identifiable plans that suggest increases in electrification?

• **Forecasted Freight Growth Rates:** Considering recent congestions at the ports, what are your thoughts about the short term and long-term growth rate assumptions embedded in this draft?

• **Load and Emissions Factors:** Future updates may include PEMS data sampled from approximately 10 units, are there other data sources to consider?

• **Non-Diesel Equipment:** Outside of POLA, POLB and POAK, non-diesel equipment is not reported to either CARB or any port bodies that we are aware of, so may be missing. Are there data sources available?

Send your comments and suggestions to: Elizabeth.Mazmanian@arb.ca.gov
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Ocean-Going Vessels (OGV)

Background and Major Updates
OGV Inventory

- OGV inventory covers marine vessels over 400 feet, 10,000 tons, with large engine displacement
- At-Berth inventory updated in 2020
- Inventory updates for transit, maneuvering, anchorage are needed
  - Improve base year accuracy and location specificity
  - Review growth forecast and future engine Tiers for visiting vessels
  - Review literature on emission factors for main/auxiliary engines and boilers
Modes of Operation

- **At-Berth**: Operations while moored to a dock
- **Anchorage**: Operations when vessel drops anchor near the port
- **Maneuvering**: Slow speed vessel operations while in port areas
- **Transit**: Vessel operations between ports
Ocean-Going Vessels (OGV)

Data Sources and Method
### Data Sources: Overview

<table>
<thead>
<tr>
<th>Vessel Activity</th>
<th>Emission Factors</th>
<th>Engine Defaults</th>
<th>Forecasting</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020 AIS Records</td>
<td>2020 EPA EFs</td>
<td>2020 IHS Records</td>
<td>FAF 4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2020 Starcrest</td>
<td>Historical Port Calls</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2019 Industry</td>
<td>Mercator Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2020 Tioga Report</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Control Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020 IHS Records</td>
<td>2019 Compliance</td>
</tr>
</tbody>
</table>

**Note:** Freight Analysis Framework (FAF)
Activity Data Source: AIS

- Automatic Identification System (AIS) is an onboard navigation safety device that all OGVs are required to equip for improved navigation and collision avoidance.

- AIS reports provide vessel location and movement information in US waterways.

- This massive data source is made public through collaboration of the USCG, NOAA, and the Bureau of Ocean and Energy Management (BOEM) via Marine Cadastre.

https://coast.noaa.gov/htdata/CMSP/AISDataHandler/2020/index.html
Processing AIS

- OGV records are matched with EPA emissions factors and default loads by vessel type, engine type, and activity.
- Activity defined by location and speed.

* This figure depicts one month of cleaned AIS data for illustration purposes only.

**Activity Modes:**

- **Berth Hotelling**
  - Within 4 km of port, not in anchorage zone, and speed of 0 kts

- **Anchorage Hotelling**
  - Within anchorage zone with speed < 1 kts

- **Maneuvering**
  - Within 3 nm, speed < 3 kts
Statewide 2020 OGV by Type
Out to 24 nm from shoreline

Vessel Type

- Anchorage Hotelling
- Berth Hotelling
- Maneuvering
- Transit

Total Observed Hours, Thousands

Energy Used, kWh, x100,000
Engine Default Loads

- Boiler proposed default values from Ports’ emissions inventory (developed by Starcrest) were used directly for all vessels.

- Tanker loading and discharge activities in Richmond were adjusted with custom power operations based on 2019 industry data.

- Auxiliary engine max power was derived from IHS annual averages by type and size, then combined with Starcrest loads by activity.

Operational kW = [engine load] * [Max aux power]
Example: Applying Aux Loads

On average, IHS registry shows **3180 kW** max aux power for all 8,000 TEU capacity containerships identified in 2020 AIS records.

Records with known max aux power:

2020 activity record shows an 8,401 TEU capacity containership at anchor with max installed aux engine power of **3,300 kW**. The estimated operational kW for aux engines for that record would be **1,298 kW**.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Starcrest Default</th>
<th>Fractional Load = (Starcrest/IHS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit</td>
<td>1,553</td>
<td>0.4885</td>
</tr>
<tr>
<td>Maneuvering</td>
<td>2,485.5</td>
<td>0.7818</td>
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<tr>
<td>Berth</td>
<td>1,116.5</td>
<td>0.3512</td>
</tr>
<tr>
<td>Anchorage</td>
<td>1,250.5</td>
<td>0.3933</td>
</tr>
</tbody>
</table>

Records without known max aux power:

Using **default values** for operating power instead of adjusting unique vessel power. In example record above, the estimated operational aux power in unknown max power case would be **1,250.5 kW**.

Statewide average max power of some vessel types and sizes were lower than Starcrest reported defaults. Fractional loads were adjusted to not exceed 1 for those types and sizes, as shown in following slides.
Aux Operational kW: Maneuvering

- Starcrest Proposed Defaults
- 2020 CARB Applied Defaults

Note: Container size bins in thousand TEU capacity
Aux Operational kW: Other Modes

Starcrest Proposed Defaults  
2020 CARB Applied Defaults

Transit
- Container 1
- Reefer

Anchorage
- Reefer

Berth
- General Cargo
- Reefer
NOx Emissions Factors Comparison: Main Engines

Old Inventory  Draft Update

<table>
<thead>
<tr>
<th>Engine Tier and Type</th>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>0</th>
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<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
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</thead>
<tbody>
<tr>
<td>HSD</td>
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<td>10.5</td>
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<td>13.2</td>
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<td>10.5</td>
<td>2.6</td>
<td>17</td>
<td>16</td>
<td>14.4</td>
<td>3.4</td>
</tr>
<tr>
<td>MSD</td>
<td>16</td>
<td>15</td>
<td>12</td>
<td>8</td>
<td>15</td>
<td>13</td>
<td>11</td>
<td>7</td>
<td>17</td>
<td>16</td>
<td>14.4</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Note: High Speed Diesel (HSD), Medium Speed Diesel (MSD), Slow Speed Diesel (SSD)
NOx Emissions Factors Comparison: Auxiliary Engines and Boilers

Note: High Speed Diesel (HSD), Medium Speed Diesel (MSD), Slow Speed Diesel (SSD)
PM Emissions Factors Comparison: Distillate Fueled Engines and Boilers

Note: High Speed Diesel (HSD), Medium Speed Diesel (MSD), Slow Speed Diesel (SSD)
Ocean-Going Vessels (OGV)

Forecasting Assumptions
Forecasting Data Source: FAF

Containership FAF4.4 Growth in LA Region

COVID adjustment to delay Lo Scenario 2021 growth rates by 2 years, before resuming at expected 3.52% growth in 2023.

FAF 4.4 Lo Scenario has 2.32% growth rate in 2020
Forecasting Data Source: Tioga

Containership Growth in SF Region

- **FAF 4.4 Lo Scenario**
- **Tioga, POAK**
- **Adjusted Growth**

**FAF 4.4 Lo Scenario** has **2.33 % growth rate in 2020**

**Adjustment to keep FAF Lo Scenario growth rates through 2025, then following Tioga report at expected 1.70 % growth beginning 2026.**
Containership Capacity Trends

Containerships Calling to SPBP Have Larger Capacity Over Last 14 Years

- Less than 4000 TEU
- 4001 - 8000 TEU
- 8001 - 16000 TEU
- More than 16000 TEU

Total Arrivals (PoLA + PoLB)

Calendar Year

Containership Capacity Adjustment

- TEU and freight growth from 2012 have largely been met by increase in vessel sizes

- Container vessels above 8000 TEU capacity were grown enough to meet increased freight forecast from FAF4.4 slow growth scenario.

- Container vessels below 8000 maintained at current capacity, no growth
SPBP TEU Capacity by Size Bin Group

42 million TEU Capacity, SPBP Master Plan

Throughput TEUs, Millions

Calendar Year

- Less than 4000 TEU
- 4001 - 8000 TEU
- 8001 - 16000 TEU
- More than 16000 TEU
Containership Capacity NOx Impacts

South Coast Containership NOx by Size Bin Group

- Less than 4000 TEU
- 4001 - 8000 TEU
- 8001 - 16000 TEU
- More than 16000 TEU

Calendar Year

NOx, tpd
Tier Assumptions

• Based on Mercator report, growth of Tier III vessels delayed until 2030.

• Main engine duty cycle adjustment: All Tier III main engines operating at less than 25% load are assumed to be operating at Tier II levels.
Ocean-Going Vessels (OGV)

Statewide Emissions Impacts
Statewide Containership NOx by Tier

Out to 100 nm from shoreline

- Tier 0
- Tier I
- Tier II
- Tier III

Calendar Year

NOx, tpd

South Coast Containership NOx by Tier

Out to 100 nm from shoreline

- Tier 0
- Tier I
- Tier II
- Tier III

Calendar Year

NOx, tpd
Bay Area Containership NOx by Tier

Out to 100 nm from shoreline

Calendar Year

Tier 0  Tier I  Tier II  Tier III

NOx, tpd

Statewide NOx Emissions Out to 100 nm

Draft AIS Update by Vessel Type

- Auto Carrier
- Bulk Cargo
- Container
- Cruise
- General Cargo
- Reefer
- RoRo
- Tanker
- Vessels (Other)
- Old Inventory

Calendar Year

NOx, tpd

CARB
South Coast NOx Emissions Out to 24 nm

Draft AIS Update by Vessel Type

- Auto Carrier
- Bulk Cargo
- Container
- Cruise
- General Cargo
- Reefer
- RoRo
- Tanker
- Vessels (Other)
- Old Inventory

Calendar Year

NOx, tpd

South Coast NOx Emissions Out to 24 nm
Bay Area NOx Emissions Out to 24 nm

Draft AIS Update by Vessel Type

- Auto Carrier
- Bulk Cargo
- Container
- Cruise
- General Cargo
- Reefer
- RoRo
- Tanker
- Vessels (Other)
- Old Inventory

Calendar Year

NOx, tpd
Topics to Consider

• **Tier III Penetration**: Are there current or ongoing studies showing different values for the large-scale arrival of Tier III vessels at CA ports?

• **Tier III Low Load Operation**: How can we improve data on the emissions from Tier III engines operating under 25% load?

• **Forecasted Freight Growth Rates**: Considering recent congestions at the ports, how will long term growth be impacted, and should congestion be reflected in the forecast?

Send your comments and suggestions to: Nancy.Bui@arb.ca.gov
Recent Congestion at the Ports

• Major seaports in California have been experiencing a substantial increase in cargo imports, resulting in significant congestion at terminals and in surrounding areas.
• According to the Marine Exchange of Southern California, as of September 17, 2021, there were 65 container vessels (total of 86 vessels) at anchor near the San Pedro Bay Ports
• CARB’s assessment of the emissions impact of recent congestion at major seaports can be found at: https://ww2.arb.ca.gov/sites/default/files/2021-09/port_congestion_anchorage_locomotives_truck_emissions_final%28002%29.pdf
Next Steps

CARB Public Workshop
• Statewide level details
• September 22, 2021

Draft Release
• Open for public comments through
• October 13, 2021

Final Release
• Inclusion in 2022 South Coast SIP emissions inventory
• November/December 2021
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• Cory Parmer, Manager, Off-Road Diesel Analysis Section
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• Sam Pournazeri, Chief, Mobile Source Analysis Branch
  Sam.Pournazeri@arb.ca.gov

• Useful Links:
  o 2011 CHE Emissions Inventory:
  o 2019 At Berth Emissions Inventory:
  o 2011 OGV Emissions Inventory:
  o 2022 State Strategy for the State Implementation Plan:
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