Category 1 / Category 2 Vessel Port Underway Split for 2011 National Emission Inventory

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Eastern Research Group
Introduction

where \( f_{d1} \) = the apportioning factor for distillate fuel sold in port 1,

\[ N_{d1} = \text{the number of vessels with less than 18 feet of draft using port 1}, \]

\[ N_{d2} = \text{the number of vessels with 18 feet or more of draft using port 1}, \]

\[ N_{d3} = \text{the number of vessels with less than 18 feet of draft using all ports within the state, and} \]

\[ N_{d4} = \text{the number of vessels with 18 feet or more of draft using all ports within the state.} \]

In Equation 7-6, larger vessels (those drawing 18 feet of more) are weighted by a factor of 2, which accounts for both the greater quantity of fuel used by these vessels while moving, and the use of auxiliary power generation systems by these larger vessels while at dockside. The estimated quantity of distillate fuel sold in port i is the product of the total distillate fuel sold in the state for marine use and the apportioning factor, \( f_{d1} \).

All of the fuel sold in port i is not used there. An assumption can be made, however, that 25 percent of the residual oil and 75 percent of the distillate oil sold in port i is used there. This is based on methods developed by the EPA. The total estimated quantities of residual and distillate oil used in port i are:

\[ Q_{d1} = 0.75 \times f_{d1} \times Q_{d} \text{ for distillate, and} \]

\[ Q_{d1} = 0.25 \times f_{d1} \times Q_{d} \text{ for residual, and} \]

where \( Q_{d} \) and \( Q_{d1} \) = the quantities of residual and distillate oil, respectively, used in port i;

\( f_{d1} \) and \( f_{d1} \) = the apportioning factors for residual and distillate oil, computed from Equations 7-5 and 7-6, respectively, and

\[ Q_{d} \] and \( Q_{d1} \) = the total quantities of residual and distillate oil sold in the state for marine use, from Reference 11.

To estimate emissions, an emission factor is applied to the quantities \( Q_{d} \) and \( Q_{d1} \). These emission factors are found in APE.

2
Category 1/2 Census

CATEGORY 2 VESSEL CENSUS, ACTIVITY, AND SPATIAL ALLOCATION ASSESSMENT
AND CATEGORY 1 AND CATEGORY 2 IN-PORT/AT-SEA SPLITS

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Prepared by:
Eastern Research Group, Inc.
1600 Perimeter Park Drive
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February 16, 2007
<table>
<thead>
<tr>
<th>Vessel Type</th>
<th>Vessel Characteristics</th>
<th>Activity</th>
<th>Spatial elements</th>
</tr>
</thead>
</table>
| Tugboats            | American Waterways Operators  
U.S. Coast Guard Merchant Vessels of the U.S.  
U.S. ACE Waterborne Transportation Lines of the U.S.  
Inland River Record  
IHS Registry of Ships  
American Bureau of Shipping | American Waterways Operators  
U.S. ACE Waterborne Transportation Lines of the U.S.  
U.S. Coast Guard Vessel Movement Database | BTS Transportation Atlas  
U.S. ACE Waterborne Commerce  
U.S. ACE Waterborne Transportation Lines of the U.S.  
U.S. ACE Waterway Link Commodity Data |
| Commercial Fishing   | U.S. Coast Guard Merchant Vessels of the U.S.  
California Commercial fishing Data  
Alaska CFEC permits  
Washington Department of Fish and Wildlife. | NOAA, National Marine Fisheries Service | NOAA, National Marine Fisheries Service |
| Coast Guard         | U.S. Coast Guard Website                                                               |                                                                           | U.S. Coast Guard Website                                           |
| Ferries             | Inland River Record  
American Bureau of Shipping | American Public Transportation Association, Public Transportation Fact book | BTS National Ferry Database                                        |
| Small deepwater cargo vessels | IHS Register of Ships  
American Bureau of Shipping | U.S. ACE Vessel Clearance and Entrance Data  
U.S. Coast Guard Vessel Movement Database | BTS Transportation Atlas  
U.S. ACE Waterway Link Commodity Data |
| Offshore support vessels | Offshore Marine Service Association  
Rig zone  
U.S. Coast Guard Merchant Vessels of the U.S.  
Offshore Support Vessels of the World. | BOEM Gulf of Mexico emission inventory Workboat (publication) | BOEM Gulf of Mexico emission inventory  
EPA 2011 NEI data file |
| Great Lake Vessels   | IHS Register of Ships  
American Bureau of Shipping | U.S. ACE Vessel Clearance and Entrance Data  
U.S. Coast Guard Vessel Movement Database | BTS Transportation Atlas  
U.S. ACE Waterway Link Commodity Data |
| Research Vessels     | IHS Register of Ships  
American Bureau of Shipping | University of Delaware database of Research vessels  
University- National Laboratory System  
Ocean Physics Laboratory | University of Delaware database of Research vessels  
University- National Laboratory System |

General Approach
Data Compilation / Activity Estimation

\[ Thp-hr_{ij} = VP_i \times UR_i \times EN_i \times HP_{ij} \times DO_{ij} \times 24 \times LF_{ij} \]

Where:

- \( Thp-hr_{ij} \) = Total horsepower hours for vessel type \( i \) in mode \( j \)
- \( VP_i \) = Population of vessel type \( i \)
- \( UR_i \) = Utilization rate for vessel fleet \( i \)
- \( EN_i \) = Average number of engines on vessel type \( i \)
- \( HP_{ij} \) = Horsepower of vessel type \( i \)
- \( DO_{ij} \) = Days of operation for vessel type \( i \) in mode \( j \)
- 24 = Hours per day
- \( LF_{ij} \) = Load factor of vessel type \( i \) propulsion engines in mode \( j \)
- \( i \) = Vessel type (i.e., deep water, tow, ferries commercial fishing, Great Lakes, Coast Guard, offshore support, and research)
- \( J \) = Mode of operation (i.e., underway cruise, underway idle)
Variance / Uncertainty

Table 1-3. Category 2 Propulsion Horsepower Hours by Vessel Type

<table>
<thead>
<tr>
<th>Vessel Type</th>
<th>Mean Values (million hp-hrs)</th>
<th>Standard Deviation (million hp-hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Water</td>
<td>2.666</td>
<td>698</td>
</tr>
<tr>
<td>Towboat</td>
<td>7.920</td>
<td>3.020</td>
</tr>
<tr>
<td>Ferry</td>
<td>1.464</td>
<td>443</td>
</tr>
<tr>
<td>Fishing</td>
<td>3.413</td>
<td>1.143</td>
</tr>
<tr>
<td>Great Lakes</td>
<td>1.393</td>
<td>405</td>
</tr>
<tr>
<td>Coast Guard</td>
<td>1.441</td>
<td>496</td>
</tr>
<tr>
<td>Offshore</td>
<td>27.810</td>
<td>11.933</td>
</tr>
<tr>
<td>Research</td>
<td>654</td>
<td>217</td>
</tr>
</tbody>
</table>

Figure 3-5 - Commercial Fishing Vessel HP-HR Calculation Frequency Chart
Port/Underway splits

Table 1-4. Average In-Port and At-Sea Fraction by Vessel Type for Vessels Equipped with 2 Propulsion Engines

<table>
<thead>
<tr>
<th>Vessel Type</th>
<th>In-Port</th>
<th>At-Sea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Towboats</td>
<td>17%</td>
<td>83%</td>
</tr>
<tr>
<td>Fishing</td>
<td>5%</td>
<td>95%</td>
</tr>
<tr>
<td>Offshore</td>
<td>4%</td>
<td>96%</td>
</tr>
<tr>
<td>Ferries</td>
<td>65%</td>
<td>35%</td>
</tr>
<tr>
<td>Deepwater</td>
<td>1%</td>
<td>99%</td>
</tr>
<tr>
<td>Research</td>
<td>1%</td>
<td>99%</td>
</tr>
<tr>
<td>Great Lakes</td>
<td>1%</td>
<td>99%</td>
</tr>
<tr>
<td>Government</td>
<td>59%</td>
<td>41%</td>
</tr>
</tbody>
</table>

**Weighted Average**

<table>
<thead>
<tr>
<th>In-Port</th>
<th>At-Sea</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>90%</td>
</tr>
</tbody>
</table>
General Approach
Spatial Allocations

Activity by Vessel Type

In-Port
- Allocated to Individual Ports Based on:
  - Cargo Handled
  - Fish Catch Processed
  - Vessel Home Port

At-Sea
- Allocate to:
  - Shipping Lane
  - Fishing Zone
  - Coast Guard District
  - Offshore Oil Platforms
  - Research Area

Applied to GIS Map Overlaid with County/Federal Boundary Shape

County Level Activity by Vessel Type
Example of Spatial Allocations

Figure B-1. Tug/Towboat In-Port Activity

Figure B-2. Tug/Towboat At-Sea Activity
Data Generated

![Database Screenshot]

- **Security Warning:** Certain content in the database has been disabled.

### Deepwater_Port

<table>
<thead>
<tr>
<th>BlockID</th>
<th>Activity</th>
<th>Add New Field</th>
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</thead>
<tbody>
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<td>01097_0</td>
<td>657730.907278</td>
<td></td>
</tr>
<tr>
<td>02020_0</td>
<td>516788.570004</td>
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</tr>
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<td>46980.779013</td>
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<td></td>
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<tr>
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<td>422827.011822</td>
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<td>06067_0</td>
<td>70471.168637</td>
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<td>10003_0</td>
<td>23490.3895457</td>
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<td>18089_0</td>
<td>23490.3895457</td>
<td></td>
</tr>
<tr>
<td>22019_0</td>
<td>493298.180459</td>
<td></td>
</tr>
</tbody>
</table>

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*Table containing data from Deepwater_Port*
The activity for port and underway operations for all C1/C2 vessel types were aggregated and used as a weight factor for each allocation block and vessel operations using the following equation:

\[ SA_{ij} = \frac{A_{ij}}{\sum A_{ij}} \]

Where:
- \( SA_{ij} \) = Spatial activity factor for vessel type \( i \) operating in block \( J \)
- \( A_{ij} \) = Census Report activity for vessel type \( i \) in block \( J \)
- \( i \) = Vessel type (e.g., tug, ferry, fishing) and operation (i.e., port, underway)
- \( J \) = Specific spatial block

<table>
<thead>
<tr>
<th>Vessel Type</th>
<th>% of Port Activity</th>
<th>% of Sea Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deepwater</td>
<td>0.0791%</td>
<td>7.8333%</td>
</tr>
<tr>
<td>Ferries</td>
<td>2.8246%</td>
<td>1.5210%</td>
</tr>
<tr>
<td>Fishing</td>
<td>0.5064%</td>
<td>9.6219%</td>
</tr>
<tr>
<td>Government</td>
<td>2.5239%</td>
<td>1.7539%</td>
</tr>
<tr>
<td>GreatLake</td>
<td>0.0413%</td>
<td>4.0934%</td>
</tr>
<tr>
<td>Support (Offshore &amp; Research)</td>
<td>1.7766%</td>
<td>43.9192%</td>
</tr>
<tr>
<td>Tugs</td>
<td>3.9959%</td>
<td>19.5094%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11.7479%</strong></td>
<td><strong>88.2521%</strong></td>
</tr>
</tbody>
</table>
Improvements

- Disaggregation of Port of Southern Louisiana and Baton Rouge port emissions to include extended boundaries of the ports

- Disaggregation of CT and MA ferry activities to all ports that reported ferry traffic in BTS’ National Census of Ferry Operators

- Reviewed tug data to check high activity in the Ohio River area
Conclusions....

- Use of the C1/C2 census data allowed for a better approximation of port and underway activities.

- Allowed activity to be developed for different vessels categories.

- Planning to update the C1/C2 census data and apply the kw-hrs to emission factors to get 2014 emissions for NEI.
Acknowledgments

- **EPA staff that supported this effort**,
  - Laurel Driver
  - Penny Carey
  - Brian Timin

- **Staff who work on the original C1/C2 report**
  - Dr. James Corbett
  - Sam Wells
  - Guiselle Aldrete

- **Staff who helped with the 2011 CMV NEI**
  - Roger Chang
  - Heather Perez
  - Jennifer Sellers
Questions?

“I’ll pause for a moment so you can let this information sink in.”