HOW TO CONDUCT AN EMISSIONS INVENTORY

One of the most accurate methods for estimating air emissions is through an activity-based emissions inventory where emission estimates are based on activity levels versus fuel or cargo based inventories. Several ports around the world have conducted activity-based emissions inventories (EI) to better assess the contribution of emissions from port-related activities. Since 2001, the Port of Los Angeles has conducted port-wide emissions inventories every year to evaluate their contribution of air pollutants to the South Coast Air Basin. The POLA EI reports have been instrumental in the development of the *San Pedro Bay Clean Air Action Plan*. By evaluating emission contributions from each source category, POLA has been able to determine what control strategies provide the best emission reduction benefits. Due to the human health risk factor, reducing emissions from POLA's port activities is very important. The annual EIs help show where emissions may have increased and where emissions have decreased due to the control options put in place.

In the technical field of estimating air emissions, there are significant distinctions between off-road and on-road vehicles or equipment. Off-road equipment includes vehicles or equipment that are not designed or licensed to operate on public roads. Off-road equipment includes cargo handling equipment, locomotives, and marine vessels. The on-road category consists of vehicles that are typically licensed to operate on public roads, such as trucks. The important distinction between these two source categories are; first, the methods by which emission are estimated and, second, that the on-road vehicles have been significantly regulated in the past (with respect to emissions) as compared to off-road equipment. Each of the source categories has different emission estimating methodologies that are summarized below. Most of the estimating methodologies are used in the United States, in particular California. Emission factors may be different for international ports. To conduct your own air emissions inventory, use emission factors recommended by your local regulatory agency.

Ocean/Sea-Going Vessels (OGVs)

OGVs consist of various types of vessels commonly distinguished by the cargo they carry. The most common classes include: auto carriers, bulk carriers, containerships, cruise ships, general cargo ships, ocean/sea-going tug boats, refrigerated vessels, roll-on roll-off (RoRo) ships, and bulk liquid tankers. The basic methodology for estimating emissions from vessels is built on previous marine emissions studies developed in California, other U.S. states, and international studies. The Port of Los Angeles developed a Vessel Boarding Program that focused on gathering specific vessel characteristics and operational data in addition to gaining a better understanding of the vessel schedules. Though the arrival and departure of an OGV into a port is a small component of the OGVs voyage, the emissions contribution is significant, especially hotelling emissions. Activity data and vessel characteristics should be used with the latest emission factors, developed from the latest emission testing data sets.

In developing an activity-based emissions inventory for marine vessels, emissions are estimated as a function of vessel power demand (expressed in kW-hrs) multiplied by an emissions factor, where the emission is expressed in terms of grams per kilowatt hour (g/kW-hr). There are two equations used to estimate OGV emissions.

Equation 1

E = Energy * EF

Where:

E = Emissions from the engine(s) that are included in the "Energy" term discussed below, usually calculated as grams of emissions per unit of time (e.g. per year), but converted to tons of emission by dividing by 453.6 grams per pound and 2000 pounds per ton.

Energy = Energy demand in kW-hrs, calculated using Equation 2 below as the energy output of the engine (or engines) over the period of time covered by the estimate.

EF = Emission Factor, usually expressed in terms of g/kW-hr, discussed in more detail below.

The "Energy" term of the equation is where most of the location specific information is used. Energy is calculated using Equation 2.

Equation 2

Energy = MCR * LF * A

Where:

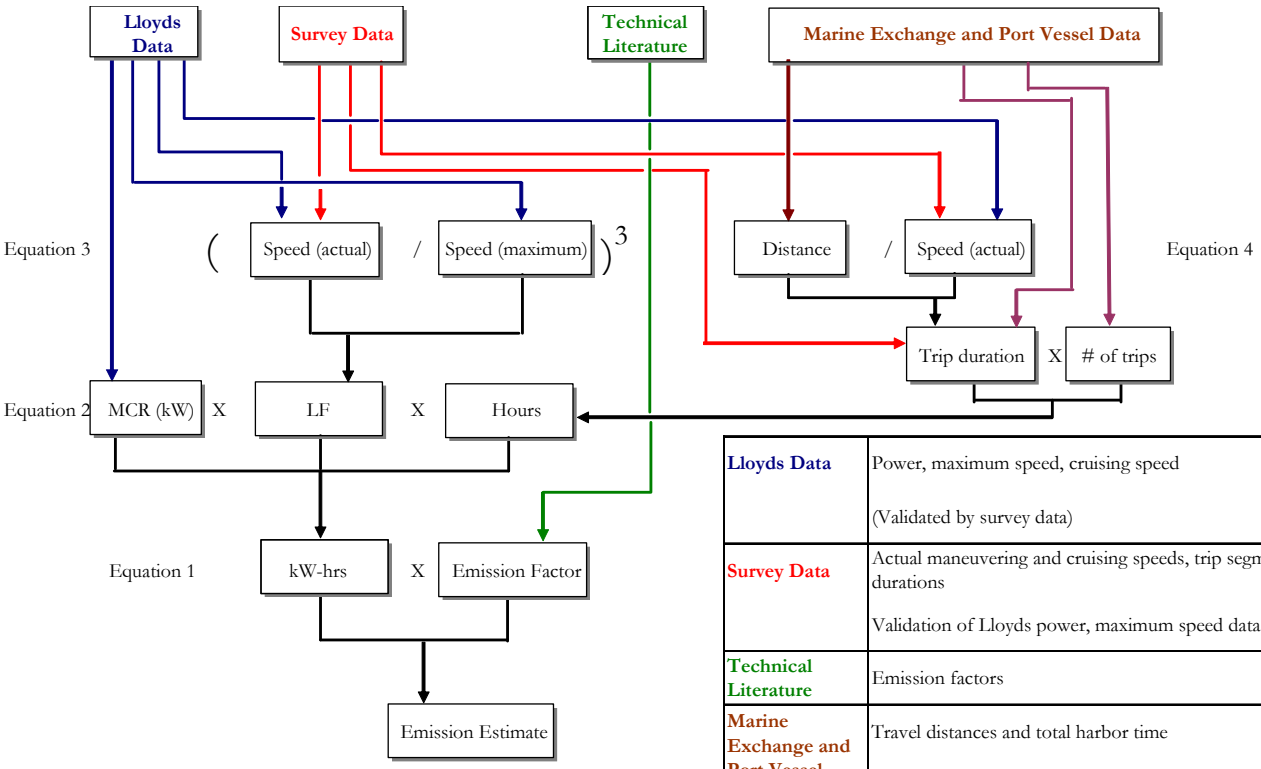
MCR = Maximum continuous rated engine power, kW

LF = Load factor (no units)

A = Activity, hours

The process for estimating emissions from propulsion engines is depicted as a process flow diagram.

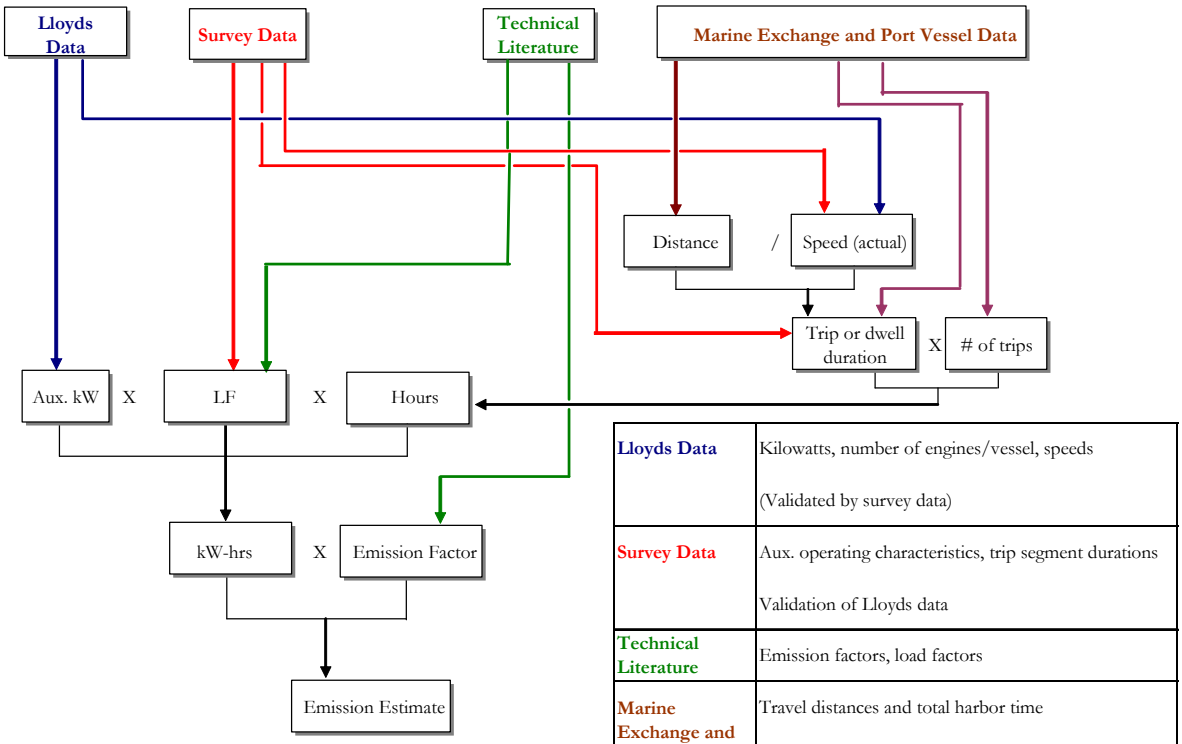
Propulsion Engine Emission Estimation Flow Diagram



Lloyds Data	Power, maximum speed, cruising speed (Validated by survey data)
Survey Data	Actual maneuvering and cruising speeds, trip segment durations Validation of Lloyds power, maximum speed data
Technical Literature	Emission factors
Marine Exchange and Port Vessel Data	Travel distances and total harbor time Number of calls, vessel identification

The process for estimating emissions for auxiliary engines is expressed in the following flow diagram.

Auxiliary Engine Emission Estimation Flow Diagram



Lloyds Data	Kilowatts, number of engines/vessel, speeds (Validated by survey data)
Survey Data	Aux. operating characteristics, trip segment durations Validation of Lloyds data
Technical Literature	Emission factors, load factors
Marine Exchange and Port Vessel Data	Travel distances and total harbor time Number of calls, vessel identification

Harbor Craft

Harbor craft are commercial marine vessels that spend the majority of their time within or near the Port and harbor. Harbor craft are a separate source category from ocean/sea-going vessels due to the different emission estimate methodology used.

Harbor craft include:

- Assist boats
- Work boats
- Towboats/push-boats/tugboats
- Ferries and excursion vessels
- Crew boats
- Government vessels
- Dredges and dredging support vessels
- Commercial fishing vessels
- Recreational vessels

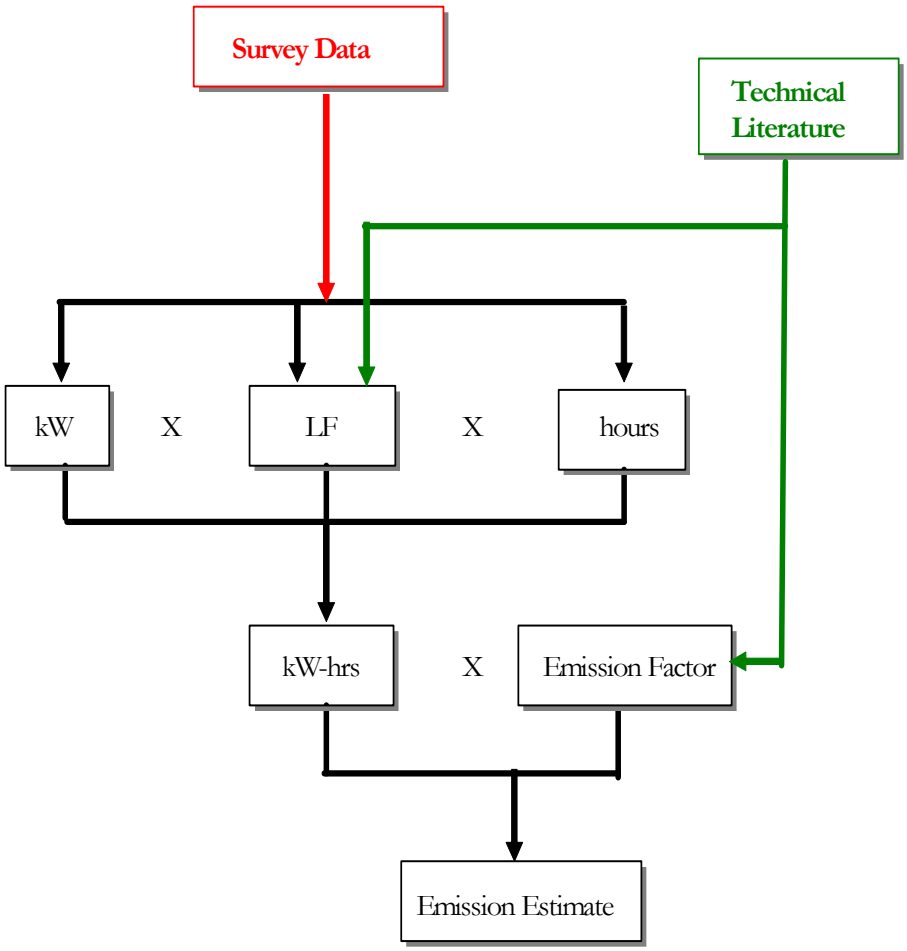
To obtain information on the types of harbor craft, interview harbor vessel operators and marina managers to help develop a harbor craft inventory list. Emission inventories in the United States used emission factors found in the 1999 EPA Final Regulatory Impact Analysis (RIA) to estimate emissions for harbor craft and Category 1 engines. For Category 2 engines emission factors were used for medium speed vessels.

To collect data for the harbor craft, identify and interview the vessel owners and operators to determine key operating parameters of interest. The following are recommended operating parameters in which to seek information on.

- Hours of operation (annual and average daily, plus schedules if relevant and available)
- Percent of time in operational modes (idling, half power, full power, etc.)
- Vessel characteristics
- Number, type and horsepower (or kilowatts) of main engine(s)
- Number, type and horsepower (or kilowatts) of auxiliary engines
- Other operational parameters such as fuel consumption rates, dredging volumes
- Qualitative information regarding how the vessels are used in service
- Information on percentage of time operating within harbor, 25 and 50 mile ranges

The process for estimating emissions for harbor craft is expressed in the following flow chart.

Harbor Craft Emissions Estimation Flow Chart



Cargo Handling Equipment

CHE consists of various types of equipment and vehicles that fall within the off-road designation and are used to move cargo within terminals and other off-road areas. For CHE, collect the following specifications for each piece of equipment:

- Equipment type, make and model
- Engine make and model
- Model year
- Horsepower
- Load data
- Annual operating hours
- Fuel used

Rail/Locomotive Activity

Railroad operations are typically described in terms of two different types of operation, line haul and switching. Line haul refers to the movement of cargo over long distances (e.g. cross country) and occurs within a port at the initiation or termination of a line haul trip, as cargo is either picked up for transport to destinations across the country or is dropped off for shipment overseas. Switching refers to the assembling and disassembling of groups of railcars at various locations in and around the Port, the sorting of the cars of inbound cargo trains into contiguous "fragments" for subsequent delivery to terminals, and the short distance hauling of rail cargo within a port.

To estimate emissions from railroad activities within a port, interview railroad operators on rail activities and board switch engines while in operation to get a better sense of their normal operations. Estimating emissions is different for line haul and switching due to the difference in operational loads and conditions.

Trucks

There are two components to the estimation of truck emissions: on-road travel and on-terminal operations. Most truck activity within a port, in terms of operating hours and miles traveled, take place on the public roads within a port as trucks travel to and from the terminals to drop off or pick up their cargo, and as they sometimes wait for entry outside terminal gates. The trucks also operate within each terminal, typically entering through a controlled access gate, traveling through the terminal to drop off and/or pick up cargo, and then exiting the terminal.

Estimating emissions for trucks may differ depending on on-terminal and off-terminal activity. Emission factors also differ depending on the model year range of the vehicle. Other elements to consider in estimating truck emissions include; gross vehicle weight rating (GVWR), distance traveled, idling time while on terminal, and fuel type.