NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Ocean Freighter, Transport

Reference Flow: 1 kg of petroleum

Brief Description: This process includes all inputs for the raw material transportation for 1 kg of petroleum.

Section I: Meta Data

Geographical Coverage: US **Region:** N/A

Year Data Best Represents: 2005

Process Type: Transport Process (TP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: Individual Relevant Flows Captured

Flows Aggregated in Data Set:

☒ Process ☒ Energy Use ☒ Energy P&D ☐ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☒ Greenhouse Gases	☒ Criteria Air Pollutants	☐ Other
Releases to Water:	☒ Inorganic Emissions	☐ Organic Emissions	☐ Other
Water Usage:	☒ Water Consumption	☒ Water Demand (throughput)	
Releases to Soil:	☒ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

Distance	*Ocean freighter transport distance*

Tracked Input Flows:

Petroleum	*The petroleum that the ocean freighter will carry*
Fuel Oil	*Fuel oil for combustion by the ocean freighter*

Tracked Output Flows:

Petroleum	*Petroleum delivered*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_RMT_Ocean_Freighter_Petroleum_2012.01.xls*, which provides additional details regarding relevant calculations, data quality, and references.

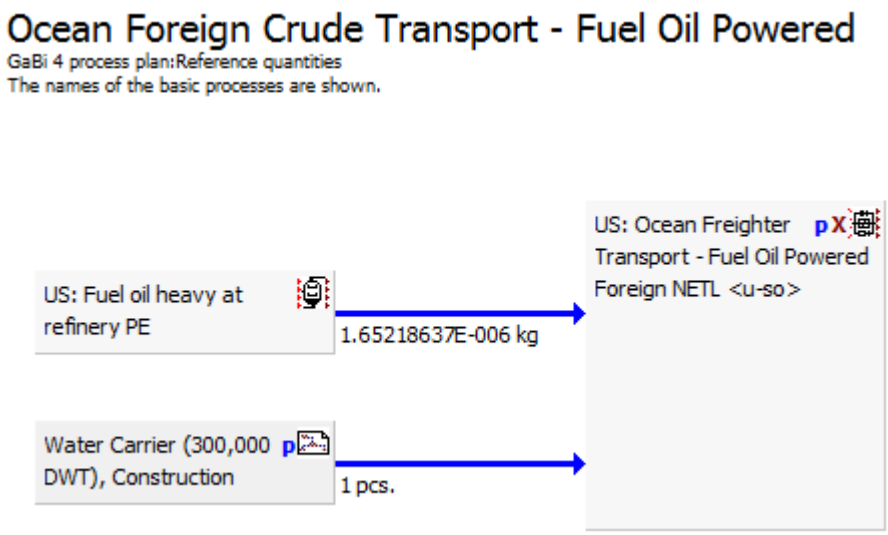
Goal and Scope

The scope of this unit process covers all aspects of raw material transportation (RMT) as seen in **Figure 1**. These processes were developed for the transportation of petroleum. At the end, one kilogram of petroleum is delivered to the life cycle (LC) Stage #3 boundary.

Boundary and Description

This unit process includes the operation of a fuel oil-powered ocean freighter. The transport distance is an adjustable parameter for RMT. The plan for RMT is provided in **Figure 1**.

Figure 1: Plan for Ocean Freighter Transportation



The profiles and processes included in RMT are provided in **Table 1**. Those shown in bold face were developed by NETL.

Table 1: Profiles and Processes Included in RMT for Ocean Freighter Transportation

Ocean Foreign Crude Transport - Fuel Oil Powered
- Water Carrier (300,000 DWT), Construction
  - DE: Lead (99,995%) PE
  - RER: Aluminum sheet mix PE
  - RER: Polyurethane flexible foam (PU) PlasticsEurope
  - **US: Fuels Tanker Trailer, 7,500 gallon, Construction NETL <u-so>**
  - US: Nylon 6 granulate (PA 6) PE
  - US: Styrene-butadiene rubber (SBR) PE
  - WOR: Steel Plate, BF, Manufacture NETL <u-so>
- US: Fuel oil heavy at refinery PE
- **US: Ocean Freighter Transport - Fuel Oil Powered Foreign NETL <u-so>**

Parameters and Balances

The parameters for the highest level modeling plan for ocean freighter transportation are shown in **Table 2**. These parameters may or may not include the adjustable parameters shown previously, depending on how the model was created. **Table 3** presents the input and output balances for resources and emissions of interest for the RMT plan.

Table 2: Adjustable Parameters for RMT of Ocean Freighter Transportation

Plan	Parameter	Value	Comment
LC Stage #2			
Stage #2: Ocean Freighter Transport	Distance	1	[mi] input ocean freighter travel distance

Table 3: Inputs and Output Balances for RMT of Ocean Freighter Transportation (kg/kg delivered)

Process or Category	Gate to Gate (RMT)
Inputs	
Flows	1.229E-02
Resources	1.229E-02
Energy resources	4.649E-04
Non renewable energy resources	4.646E-04
Crude oil (resource)	1.339E-04
Crude oil	1.038E-05
Crude oil Algeria	1.756E-06
Crude oil Angola	1.743E-06
Crude oil Argentina	4.327E-07

Process or Category	Gate to Gate (RMT)
Crude oil Australia	2.232E-06
Crude oil Austria	1.760E-07
Crude oil Bolivia	1.925E-10
Crude oil Brazil	5.547E-06
Crude oil Brunei	1.712E-12
Crude oil Bulgaria	5.232E-11
Crude oil Cameroon	2.726E-07
Crude oil Canada	5.639E-06
Crude oil Chile	3.445E-12
Crude oil China	8.612E-08
Crude oil CIS	1.776E-05
Crude oil Colombia	9.898E-07
Crude oil Czech Republic	7.566E-08
Crude oil Denmark	3.252E-06
Crude oil Ecuador	4.326E-07
Crude oil Egypt	2.225E-07
Crude oil France	4.376E-08
Crude oil Gabon	7.047E-07
Crude oil Germany	6.635E-07
Crude oil Greece	1.469E-08
Crude oil Hungary	1.601E-07
Crude oil India	2.694E-12
Crude oil Indonesia	9.105E-07
Crude oil Iran	1.709E-06
Crude oil Iraq	2.992E-06
Crude oil Ireland	3.592E-12
Crude oil Italy	3.307E-07
Crude oil Kuwait	1.131E-06
Crude oil Libya	3.545E-06
Crude oil Malaysia	1.080E-12
Crude oil Mexico	6.519E-06
Crude oil Netherlands	2.368E-07
Crude oil New Zealand	1.341E-07
Crude oil Nigeria	4.408E-06
Crude oil Norway	1.050E-05
Crude oil Oman	7.160E-08

Process or Category	Gate to Gate (RMT)
Crude oil Poland	9.375E-08
Crude oil Qatar	1.087E-07
Crude oil Romania	7.903E-08
Crude oil Saudi Arabia	9.693E-06
Crude oil Slovakia	9.874E-10
Crude oil South Africa	7.448E-14
Crude oil Spain	9.372E-09
Crude oil Syria	1.306E-10
Crude oil Trinidad and Tobago	2.635E-07
Crude oil Tunisia	1.264E-07
Crude oil Turkey	1.990E-13
Crude oil United Arab Emirates	2.995E-07
Crude oil United Kingdom	1.002E-05
Crude oil USA	2.141E-05
Crude oil Venezuela	6.760E-06
Hard coal (resource)	1.390E-04
Hard coal	1.447E-06
Hard coal Australia	4.249E-06
Hard coal Belgium	3.072E-10
Hard coal Bosnia and Herzegovina	2.949E-06
Hard coal Brazil	1.033E-07
Hard coal Canada	1.431E-06
Hard coal Chile	3.627E-10
Hard coal China	8.253E-07
Hard coal CIS	9.619E-06
Hard coal Colombia	2.925E-06
Hard coal Czech Republic	8.551E-07
Hard coal France	1.521E-07
Hard coal Germany	9.624E-06
Hard coal India	1.947E-10
Hard coal Indonesia	1.465E-06
Hard coal Italy	1.331E-08
Hard coal Japan	7.637E-13
Hard coal Malaysia	5.894E-14
Hard coal Mexico	5.812E-09
Hard coal New Zealand	3.366E-10

Process or Category	Gate to Gate (RMT)
Hard coal Poland	4.004E-06
Hard coal Portugal	3.331E-13
Hard coal South Africa	8.152E-06
Hard coal Spain	1.840E-06
Hard coal Turkey	8.569E-10
Hard coal United Kingdom	3.744E-06
Hard coal USA	8.494E-05
Hard coal Venezuela	5.819E-07
Hard coal Vietnam	5.527E-08
Lignite (resource)	8.524E-05
Lignite	2.084E-07
Lignite Australia	2.047E-07
Lignite Austria	3.398E-08
Lignite Bosnia and Herzegovina	6.811E-06
Lignite Bulgaria	6.151E-07
Lignite Canada	7.118E-08
Lignite CIS	2.331E-07
Lignite Czech Republic	1.246E-06
Lignite France	5.382E-08
Lignite Germany	2.987E-10
Lignite Germany (Central Germany)	4.773E-06
Lignite Germany (Lausitz)	1.120E-05
Lignite Germany (Rheinisch)	1.954E-05
Lignite Greece	2.459E-05
Lignite Hungary	2.397E-07
Lignite India	3.895E-11
Lignite Macedonia	3.699E-07
Lignite Poland	1.349E-06
Lignite Romania	6.110E-10
Lignite Serbia and Montenegro	1.369E-09
Lignite Slovakia	1.132E-06
Lignite Slovenia	7.611E-06
Lignite Spain	3.871E-06
Lignite Turkey	2.467E-11
Lignite USA	1.084E-06
Natural gas (resource)	1.064E-04

Process or Category	Gate to Gate (RMT)
Natural gas	3.503E-06
Natural gas Algeria	2.649E-06
Natural gas Angola	2.166E-07
Natural gas Argentina	7.056E-08
Natural gas Australia	1.705E-07
Natural gas Austria	1.130E-07
Natural gas Bolivia	3.868E-07
Natural gas Brazil	1.376E-06
Natural gas Brunei	1.536E-08
Natural gas Bulgaria	1.012E-10
Natural gas Cameroon	6.807E-08
Natural gas Canada	9.388E-06
Natural gas Chile	8.188E-10
Natural gas China	6.218E-09
Natural gas CIS	8.598E-06
Natural gas Colombia	6.002E-08
Natural gas Czech Republic	1.456E-08
Natural gas Denmark	1.248E-06
Natural gas Ecuador	3.119E-08
Natural gas Egypt	2.299E-08
Natural gas France	6.044E-08
Natural gas Gabon	1.018E-07
Natural gas Germany	2.771E-06
Natural gas Greece	1.257E-08
Natural gas Hungary	1.716E-07
Natural gas India	1.493E-11
Natural gas Indonesia	4.822E-08
Natural gas Iran	1.982E-07
Natural gas Iraq	2.118E-07
Natural gas Ireland	8.313E-09
Natural gas Italy	4.881E-07
Natural gas Japan	2.492E-13
Natural gas Kuwait	6.884E-08
Natural gas Libyan	1.773E-07
Natural gas Malaysia	1.281E-08
Natural gas Mexico	4.802E-07

Process or Category	Gate to Gate (RMT)
Natural gas Netherlands	7.295E-06
Natural gas New Zealand	8.952E-09
Natural gas Nigeria	1.158E-06
Natural gas Norway	4.027E-06
Natural gas Oman	1.109E-07
Natural gas Poland	1.094E-07
Natural gas Qatar	2.936E-07
Natural gas Romania	5.078E-09
Natural gas Saudi Arabia	6.270E-07
Natural gas Slovakia	1.957E-08
Natural gas South Africa	3.887E-10
Natural gas Spain	4.254E-08
Natural gas Syria	1.403E-11
Natural gas Trinidad and Tobago	4.604E-07
Natural gas Tunisia	1.553E-08
Natural gas Turkey	2.012E-14
Natural gas United Arab Emirates	7.365E-08
Natural gas United Kingdom	6.206E-06
Natural gas USA	5.206E-05
Natural gas Venezuela	4.106E-07
Pit gas	4.608E-12
Pit Methane	7.648E-07
Uranium (resource)	4.418E-09
Nuclear energy	0.000E+00
Uranium natural	4.418E-09
Renewable energy resources	3.325E-07
Biomass	3.140E-07
Primary energy from geothermics	0.000E+00
Primary energy from hydro power	0.000E+00
Primary energy from solar energy	0.000E+00
Primary energy from waves	0.000E+00
Primary energy from wind power	0.000E+00
Renewable fuels	1.778E-13
Wood	1.849E-08
Land use	0.000E+00
Occupation	0.000E+00

Process or Category	Gate to Gate (RMT)
Biotic Production	0.000E+00
Erosion Resistance	0.000E+00
Groundwater Replenishment	0.000E+00
Mechanical Filtration	0.000E+00
Physicochemical Filtration	0.000E+00
Transformation	0.000E+00
Biotic Production	0.000E+00
Erosion Resistance	0.000E+00
Groundwater Replenishment	0.000E+00
Mechanical Filtration	0.000E+00
Physicochemical Filtration	0.000E+00
Material resources	1.183E-02
Non renewable elements	2.075E-08
Chromium	2.548E-11
Copper	3.925E-13
Iron	4.526E-09
Lead	1.224E-11
Magnesium	3.009E-14
Mercury	7.433E-12
Nickel	9.429E-14
Phosphorus	3.007E-09
Sulphur	1.317E-08
Zinc	3.040E-12
Non renewable resources	1.893E-03
Barium sulphate	2.812E-16
Basalt	3.964E-06
Bauxite	2.492E-04
Bentonite	8.094E-07
Calcium chloride	2.879E-14
Chalk (Calciumcarbonate)	1.834E-38
Chromium ore (39%)	2.965E-09
Clay	1.333E-07
Colemanite ore	1.568E-09
Copper - Gold - Silver - ore (1,0% Cu; 0,4 g/t Au; 66 g/t Ag)	2.097E-08
Copper - Gold - Silver - ore (1,1% Cu; 0,01 g/t Au; 2,86 g/t Ag)	1.278E-08
Copper - Gold - Silver - ore (1,16% Cu; 0,002 g/t Au; 1,06 g/t Ag)	7.211E-09

Process or Category	Gate to Gate (RMT)
Copper - Molybdenum - Gold - Silver - ore (1,13% Cu; 0,02% Mo; 0,01 g/t Au; 2,86 g/t Ag)	1.757E-08
Copper ore (0.14%)	4.015E-08
Copper ore (1.2%)	2.175E-09
Copper ore (4%)	2.139E-18
Copper ore (sulphidic, 1.1%)	2.537E-15
Dolomite	6.169E-07
Feldspar (aluminum silicates)	2.121E-09
Ferro manganese	4.037E-12
Fluorspar (calcium fluoride; fluorite)	1.872E-06
Granite	5.394E-19
Gypsum (natural gypsum)	7.174E-08
Heavy spar (BaSO4)	1.943E-06
Ilmenite (titanium ore)	6.577E-14
Inert rock	1.504E-03
Iron ore (56,86%)	5.399E-05
Iron ore (65%)	5.816E-09
Kaolin ore	2.815E-09
Lead - zinc ore (4.6%-0.6%)	1.648E-05
Limestone (calcium carbonate)	3.326E-05
Magnesit (Magnesium carbonate)	2.323E-12
Magnesium chloride leach (40%)	2.929E-07
Manganese ore	6.158E-10
Manganese ore (R.O.M.)	3.466E-08
Molybdenite (Mo 0,24%)	1.084E-08
Natural Aggregate	8.702E-06
Nickel ore (1,5%)	4.997E-13
Nickel ore (1.6%)	4.794E-08
Olivine	4.214E-11
Peat	1.718E-07
Phosphate ore	2.354E-12
Phosphorus minerals	2.735E-07
Phosphorus ore (29% P2O5)	1.998E-12
Potassium chloride	3.825E-08
Precious metal ore (R.O.M)	5.432E-10
Quartz sand (silica sand; silicon dioxide)	1.065E-07
Raw pumice	3.133E-11

Process or Category	Gate to Gate (RMT)
Rutile (titanium ore)	6.720E-15
sand	6.941E-09
Slate	8.709E-11
Sodium chloride (rock salt)	1.225E-05
Sodium nitrate	1.601E-18
Sodium sulphate	2.052E-10
Soil	2.844E-06
Sulphur (bonded)	1.370E-13
Talc	6.394E-12
Tin ore	2.439E-17
Titanium ore	6.144E-09
Zinc - copper ore (4.07%-2.59%)	4.132E-07
Zinc - lead - copper ore (12%-3%-2%)	2.272E-06
Zinc - lead ore (4.21%-4.96%)	7.303E-19
Zinc ore (4%)	-3.947E-07
Zinc ore (sulphidic, 4%)	1.151E-17
Renewable resources	9.936E-03
Water	6.016E-03
Water	2.864E-04
Water (feed water)	2.207E-04
Water (ground water)	1.523E-03
Water (river water)	0.000E+00
Water (sea water)	6.148E-05
Water (surface water)	3.903E-03
Water (well water)	2.120E-05
Water (with river silt)	2.329E-16
Air	3.912E-03
Carbon dioxide	6.916E-06
Nitrogen	5.112E-07
Oxygen	0.000E+00
Output	
Flows	8.370E-03
Resources	2.733E-03
Energy resources	0.000E+00
Non renewable energy resources	0.000E+00
Natural gas (resource)	0.000E+00

Process or Category	Gate to Gate (RMT)
Natural gas CIS	0.000E+00
Natural gas Denmark	0.000E+00
Natural gas Germany	0.000E+00
Natural gas Netherlands	0.000E+00
Natural gas Norway	0.000E+00
Material resources	2.733E-03
Renewable resources	2.733E-03
Water	2.729E-03
Water (river water)	2.729E-03
Water (sea water)	0.000E+00
Nitrogen	0.000E+00
Oxygen	3.691E-06
Emissions to air	5.621E-03
Heavy metals to air	5.241E-09
Antimony	5.254E-12
Arsenic (+V)	7.277E-11
Arsenic trioxide	1.175E-16
Cadmium (+II)	1.228E-11
Chromium (+III)	5.554E-14
Chromium (unspecified)	1.234E-10
Cobalt	1.028E-11
Copper (+II)	2.363E-11
Heavy metals to air (unspecified)	7.265E-14
Hydrogen arsenic (arsine)	9.752E-15
Iron	2.073E-11
Lanthanides	3.516E-15
Lead (+II)	4.748E-10
Manganese (+II)	5.543E-11
Mercury (+II)	2.717E-11
Molybdenum	1.263E-12
Nickel (+II)	4.041E-10
Palladium	7.970E-19
Rhodium	7.693E-19
Selenium	9.632E-11
Silver	2.206E-18
Tellurium	7.403E-15

Process or Category	Gate to Gate (RMT)
Thallium	1.292E-13
Tin (+IV)	6.282E-11
Titanium	2.229E-13
Vanadium (+III)	1.764E-09
Zinc (+II)	2.085E-09
Inorganic emissions to air	2.343E-03
Ammonia	7.046E-09
Ammonium	4.469E-15
Ammonium nitrate	5.322E-16
Barium	1.370E-09
Beryllium	1.611E-12
Boron compounds (unspecified)	1.099E-09
Bromine	3.715E-10
Carbon dioxide	9.958E-04
Carbon dioxide (biotic)	2.342E-07
Carbon disulphide	5.361E-12
Carbon monoxide	6.609E-06
Chloride (unspecified)	6.428E-10
Chlorine	1.220E-09
Cyanide (unspecified)	7.619E-12
Fluoride	3.533E-08
Fluorides	1.453E-11
Fluorine	1.730E-13
Helium	6.464E-12
Hydrogen	1.503E-08
Hydrogen bromine (hydrobromic acid)	1.426E-12
Hydrogen chloride	3.769E-08
Hydrogen cyanide (prussic acid)	7.597E-12
Hydrogen fluoride	3.536E-08
Hydrogen iodide	1.550E-15
Hydrogen phosphorous	1.173E-12
Hydrogen sulphide	4.637E-08
Lead dioxide	8.978E-16
Nitrogen (atmospheric nitrogen)	1.882E-06
Nitrogen dioxide	3.570E-08
Nitrogen monoxide	1.581E-09

Process or Category	Gate to Gate (RMT)
Nitrogen oxides	1.651E-06
Nitrous oxide (laughing gas)	2.289E-08
Oxygen	5.051E-07
Scandium	1.805E-15
Steam	1.331E-03
Strontium	6.687E-14
Sulphur dioxide	4.199E-06
Sulphur hexafluoride	6.277E-14
sulphur oxide	1.481E-07
Sulphuric acid	1.043E-11
Tin oxide	7.812E-17
Zinc oxide	1.562E-16
Zinc sulphate	2.450E-13
Organic emissions to air (group VOC)	2.098E-06
Group NMVOC to air	2.647E-07
Group PAH to air	3.144E-09
Anthracene	2.223E-14
Benzo{a}anthracene	1.119E-14
Benzo{a}pyrene	5.222E-11
Benzo{ghi}perylene	9.979E-15
Benzofluoranthene	1.996E-14
Chrysene	2.748E-14
Dibenz(a)anthracene	6.219E-15
Indeno[1,2,3-cd]pyrene	7.426E-15
Naphthalene	2.335E-12
Phenanthrene	7.333E-13
Polycyclic aromatic hydrocarbons (PAH)	3.089E-09
Halogenated organic emissions to air	8.831E-09
Dichloroethane (ethylene dichloride)	7.823E-15
Dichloromethane (methylene chloride)	3.257E-13
Dioxins (unspec.)	-5.553E-16
Halogenated hydrocarbons (unspecified)	3.895E-11
Polychlorinated biphenyls (PCB unspecified)	1.983E-14
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	6.156E-16
R 11 (trichlorofluoromethane)	3.230E-11
R 114 (dichlorotetrafluoroethane)	3.308E-11

Process or Category	Gate to Gate (RMT)
R 116 (hexafluoroethane)	8.706E-10
R 12 (dichlorodifluoromethane)	6.944E-12
R 13 (chlorotrifluoromethane)	4.360E-12
R 22 (chlorodifluoromethane)	7.590E-12
Tetrafluoromethane	7.836E-09
Vinyl chloride (VCM; chloroethene)	8.154E-13
Acetaldehyde (Ethanal)	3.706E-10
Acetic acid	1.614E-09
Acetone (dimethylcetone)	3.683E-10
Acrolein	1.569E-13
Aldehyde (unspecified)	1.918E-11
Alkane (unspecified)	2.825E-09
Alkene (unspecified)	1.457E-09
Aromatic hydrocarbons (unspecified)	4.161E-10
Benzene	8.163E-10
Butadiene	4.290E-15
Butane	1.313E-08
Butane (n-butane)	1.453E-09
Caprolactam	3.095E-11
Cyclohexane (hexahydro benzene)	3.594E-12
Diethylamine	1.117E-19
Ethane	4.196E-08
Ethanol	7.415E-10
Ethene (ethylene)	7.438E-12
Ethyl benzene	1.388E-09
Fluoranthene	7.241E-14
Fluorene	2.297E-13
Formaldehyde (methanal)	2.673E-09
Heptane (isomers)	2.931E-10
Hexamethylene diamine (HMDA)	2.524E-16
Hexane (isomers)	1.628E-08
Mercaptan (unspecified)	1.046E-11
Methanol	7.206E-10
NMVOC (unspecified)	9.495E-08
Octane	1.612E-10
Pentane (n-pentane)	7.812E-09

Process or Category	Gate to Gate (RMT)
Phenol (hydroxy benzene)	9.164E-14
Propane	5.663E-08
Propene (propylene)	1.289E-10
Propionic acid (propane acid)	5.599E-14
Styrene	1.354E-14
Toluene (methyl benzene)	6.431E-10
Trimethylbenzene	7.610E-16
Xylene (dimethyl benzene)	5.802E-09
Hydrocarbons (unspecified)	1.241E-08
Methane	1.771E-06
Organic chlorine compounds	4.850E-11
VOC (unspecified)	4.906E-08
Other emissions to air	3.275E-03
Exhaust	3.064E-03
non used primary energy from wind power	0.000E+00
Unused primary energy from solar energy	0.000E+00
Used air	2.105E-04
Waste heat	0.000E+00
Particles to air	1.219E-06
Dust (PM10)	4.274E-08
Dust (PM2,5 - PM10)	9.344E-09
Dust (PM2.5)	8.718E-08
Dust (unspecified)	1.080E-06
Metals (unspecified)	1.885E-11
Wood (dust)	2.883E-14
Radioactive emissions to air	3.793E-11
Antimony (Sb124)	0.000E+00
Argon (Ar41)	0.000E+00
Carbon (C14)	0.000E+00
Cesium (Cs134)	0.000E+00
Cesium (Cs137)	0.000E+00
Cobalt (Co58)	0.000E+00
Cobalt (Co60)	0.000E+00
Hydrogen (H3)	0.000E+00
Iodine (I129)	0.000E+00
Iodine (I131)	0.000E+00

Process or Category	Gate to Gate (RMT)
Krypton (Kr85)	0.000E+00
Krypton (Kr85m)	0.000E+00
Plutonium (Pu alpha)	0.000E+00
Radon (Rn222)	0.000E+00
Uranium (total)	3.793E-11
Uranium (U234)	0.000E+00
Uranium (U235)	0.000E+00
Uranium (U238)	0.000E+00
Xenon (Xe131m)	0.000E+00
Xenon (Xe133)	0.000E+00
Xenon (Xe133m)	0.000E+00
Xenon (Xe135)	0.000E+00
Xenon (Xe135m)	0.000E+00
Xenon (Xe137)	0.000E+00
Xenon (Xe138)	0.000E+00
Emissions to fresh water	1.266E-05
Analytical measures to fresh water	2.816E-07
Adsorbable organic halogen compounds (AOX)	2.377E-10
Biological oxygen demand (BOD)	7.007E-09
Chemical oxygen demand (COD)	2.161E-07
Nitrogenous Matter (unspecified, as N)	7.115E-09
Solids (dissolved)	3.237E-08
Total dissolved organic bounded carbon	3.329E-09
Total organic bounded carbon	1.543E-08
Heavy metals to fresh water	1.737E-07
Antimony	1.484E-16
Arsenic (+V)	3.230E-11
Cadmium (+II)	4.378E-11
Chromium (+III)	1.245E-11
Chromium (+VI)	3.592E-13
Chromium (unspecified)	8.115E-11
Cobalt	1.248E-13
Copper (+II)	1.517E-10
Heavy metals to water (unspecified)	1.905E-12
Iron	1.712E-07
Lead (+II)	2.057E-10

Process or Category	Gate to Gate (RMT)
Manganese (+II)	4.106E-10
Mercury (+II)	1.579E-12
Molybdenum	9.112E-11
Nickel (+II)	1.141E-10
Selenium	1.653E-11
Silver	4.268E-13
Strontium	1.023E-09
Thallium	4.292E-15
Tin (+IV)	4.056E-13
Titanium	9.901E-12
Vanadium (+III)	3.189E-11
Zinc (+II)	1.983E-10
Inorganic emissions to fresh water	1.017E-05
Acid (calculated as H+)	4.955E-08
Aluminum (+III)	2.968E-09
Ammonia	4.547E-09
Ammonium / ammonia	9.448E-09
Barium	1.297E-10
Beryllium	1.136E-13
Boron	6.613E-10
Bromate	4.314E-13
Bromine	2.606E-14
Calcium (+II)	7.537E-07
Carbonate	1.515E-08
Chlorate	4.057E-10
Chloride	5.805E-06
Chlorine (dissolved)	4.070E-09
Cyanide	4.633E-11
Fluoride	2.914E-07
Fluorine	2.811E-12
Hydrogen chloride	5.844E-14
Hydrogen fluoride (hydrofluoric acid)	3.422E-14
Hydroxide	1.526E-07
Inorganic salts and acids (unspecified)	9.940E-21
Magnesium (+III)	2.142E-08
Magnesium chloride	2.168E-13

Process or Category	Gate to Gate (RMT)
Metal ions (unspecific)	1.963E-08
Neutral salts	2.053E-13
Nitrate	7.476E-08
Nitrogen	8.009E-09
Nitrogen organic bounded	2.064E-09
Phosphate	3.554E-10
Phosphorus	3.171E-09
Potassium	1.618E-09
Silicate particles	2.416E-14
Sodium (+I)	2.205E-06
Sodium chloride (rock salt)	4.210E-13
Sodium hypochlorite	1.758E-12
Sulphate	7.440E-07
Sulphide	1.440E-09
Sulphite	1.988E-10
Sulphur	1.143E-11
Sulphuric acid	7.534E-12
Organic emissions to fresh water	1.011E-08
Halogenated organic emissions to fresh water	3.932E-13
1,2-Dibromoethane	8.442E-16
Chlorinated hydrocarbons (unspecified)	1.669E-19
Chloromethane (methyl chloride)	3.915E-13
Dichloroethane (ethylene dichloride)	1.624E-17
Dichloropropane	2.026E-19
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	8.537E-19
Vinyl chloride (VCM; chloroethene)	8.452E-16
Hydrocarbons to fresh water	6.155E-09
Acenaphthene	2.433E-14
Acenaphthylene	9.958E-15
Acetic acid	4.744E-11
Acrylonitrile	1.481E-14
Anthracene	3.562E-14
Aromatic hydrocarbons (unspecified)	1.792E-10
Benzene	4.774E-11
Benzo{a}anthracene	3.383E-15
Benzofluoranthene	1.815E-15

Process or Category	Gate to Gate (RMT)
Chrysene	1.517E-14
Cresol (methyl phenol)	2.958E-13
Ethyl benzene	2.625E-12
Fluoranthene	4.612E-15
Hexane (isomers)	3.235E-14
Hydrocarbons (unspecified)	1.155E-09
Methanol	3.974E-09
Oil (unspecified)	3.494E-10
Phenol (hydroxy benzene)	1.012E-10
Polycyclic aromatic hydrocarbons (PAH, unspec.)	2.467E-10
Toluene (methyl benzene)	3.010E-11
Xylene (isomers; dimethyl benzene)	2.080E-11
Carbon, organically bound	2.405E-09
Naphthalene	1.445E-12
Organic chlorine compounds (unspecified)	6.730E-12
Organic compounds (dissolved)	6.695E-10
Organic compounds (unspecified)	8.756E-10
Other emissions to fresh water	0.000E+00
non used primary energy from water power	0.000E+00
Unused primary energy from geothermal	0.000E+00
Waste heat	0.000E+00
Particles to fresh water	2.023E-06
Metals (unspecified)	2.078E-10
Silicon dioxide (silica)	1.135E-15
Soil loss by erosion into water	6.345E-13
Solids (suspended)	2.010E-06
Suspended solids, unspecified	1.251E-08
Radioactive emissions to fresh water	0.000E+00
Americium (Am241)	0.000E+00
Antimony (Sb124)	0.000E+00
Antimony (Sb125)	0.000E+00
Carbon (C14)	0.000E+00
Cesium (Cs134)	0.000E+00
Cesium (Cs137)	0.000E+00
Cobalt (Co58)	0.000E+00
Cobalt (Co60)	0.000E+00

Process or Category	Gate to Gate (RMT)
Curium (Cm alpha)	0.000E+00
Hydrogen (H3)	0.000E+00
Iodine (I129)	0.000E+00
Iodine (I131)	0.000E+00
Manganese (Mn54)	0.000E+00
Plutonium (Pu alpha)	0.000E+00
Radium (Ra226)	0.000E+00
Ruthenium (Ru106)	0.000E+00
Silver (Ag110m)	0.000E+00
Strontium (Sr90)	0.000E+00
Uranium	0.000E+00
Emissions to sea water	3.243E-06
Analytical measures to sea water	6.498E-09
Adsorbable organic halogen compounds (AOX)	2.767E-16
Biological oxygen demand (BOD)	3.053E-10
Chemical oxygen demand (COD)	5.887E-09
Total organic bounded carbon	3.053E-10
Heavy metals to sea water	8.119E-10
Arsenic (+V)	2.074E-11
Cadmium (+II)	1.335E-11
Chromium (unspecified)	4.377E-11
Cobalt	1.211E-11
Copper (+II)	4.617E-11
Iron	1.599E-10
Lead (+II)	1.012E-11
Manganese (+II)	1.667E-11
Mercury (+II)	1.987E-13
Molybdenum	8.692E-14
Nickel (+II)	2.019E-11
Silver	2.579E-13
Strontium	2.156E-10
Tin (+IV)	3.089E-13
Titanium	3.146E-14
Vanadium (+III)	8.342E-12
Zinc (+II)	2.440E-10
Inorganic emissions to sea water	2.991E-06

Process or Category	Gate to Gate (RMT)
Aluminum (+III)	1.013E-12
Ammonia	3.010E-11
Barium	5.870E-10
Beryllium	6.871E-13
Boron	1.638E-11
Calcium (+II)	1.789E-09
Carbonate	3.691E-08
Chloride	2.922E-06
Magnesium	4.850E-10
Nitrate	4.787E-11
Sodium (+I)	6.097E-09
Sulphate	1.562E-08
Sulphide	6.707E-09
Sulphur	8.764E-12
Organic emissions to sea water	1.805E-09
Hydrocarbons to sea water	1.785E-09
Acenaphthene	6.186E-13
Acenaphthylene	2.361E-13
Acetic acid	1.313E-12
Anthracene	1.852E-13
Aromatic hydrocarbons (unspecified)	3.053E-12
Benzene	1.478E-10
Benzo{a}anthracene	1.370E-13
Benzofluoranthene	1.507E-13
Chrysene	7.709E-13
Cresol (methyl phenol)	2.270E-13
Ethyl benzene	1.523E-11
Fluoranthene	1.606E-13
Hexane (isomers)	2.478E-14
Oil (unspecified)	1.196E-09
Phenol (hydroxy benzene)	2.588E-10
Toluene (methyl benzene)	8.568E-11
Xylene (isomers; dimethyl benzene)	7.440E-11
Naphthalene	2.008E-11
Particles to sea water	2.430E-07
Solids (suspended)	2.430E-07

Process or Category	Gate to Gate (RMT)
Emissions to industrial soil	2.085E-08
Heavy metals to industrial soil	4.886E-09
Arsenic (+V)	6.771E-15
Cadmium (+II)	1.062E-12
Chromium (+III)	2.269E-11
Chromium (unspecified)	1.498E-11
Cobalt	2.417E-13
Copper (+II)	2.282E-11
Iron	2.033E-11
Lead (+II)	3.403E-11
Manganese (+II)	4.891E-12
Mercury (+II)	2.271E-13
Nickel (+II)	2.225E-11
Strontium	4.650E-09
Zinc (+II)	9.258E-11
Inorganic emissions to industrial soil	1.561E-08
Aluminum (+III)	1.844E-11
Ammonia	7.320E-09
Bromide	2.071E-12
Calcium (+II)	9.232E-10
Chloride	2.470E-09
Fluoride	6.905E-11
Magnesium (+III)	1.276E-10
Phosphorus	7.568E-10
Potassium (+I)	1.976E-09
Sodium (+I)	8.076E-11
Sulphate	2.671E-10
Sulphide	1.603E-09
Organic emissions to industrial soil	3.526E-10
Oil (unspecified)	3.526E-10

Embedded Unit Processes

NETL (2009). NETL Life Cycle Inventory Data – Process Documentation File: Ocean Freighter Transport, Operations. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: July 2010 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

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None.

Section III: Document Control Information

Date Created: September 12, 2011

Point of Contact: Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV

Revision History:

Original/no revisions

How to Cite This Document: This document should be cited as:

NETL (2012). *NETL Life Cycle Inventory Data – Unit Process: Ocean Freighter Petroleum, Transport.* U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: May 2012 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

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