NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Petroleum Based Kerosene Jet Fuel Energy Conversion Facility

Reference Flow: 1 kg of Kerosene Jet Fuel

Brief Description: This process includes all inputs required for the conversion of crude oil to kerosene jet fuel, based on the production of 1 kg of finished kerosene jet fuel.

Section I: Meta Data

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

Year Data Best Represents: 2005

Process Type: Energy Conversion (EC)

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

Allocation Applied: Yes

Completeness: All 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:

S3_DELTA_GHGA	*Adjusts refinery CO_2 emissions per change in crude oil source*
S3_FENERGY	*Fraction of refinery energy attributable to a chosen refinery product – i.e., attributable to kerosene jet fuel*
S3_FH2	*Fraction of refinery hydrogen attributable to a chosen refinery product – i.e., attributable to kerosene jet fuel*
S3_RHO_BBL	*Density of refinery product, based on the specific gravity of input crude*

Tracked Input Flows:

Crude Oil NETL [Crude oil products]	*The quantity of crude oil used to run the energy conversion facility (refinery) process*

Tracked Output Flows:

Kerosene Jet Fuel [Valuable substance]	*Finished kerosene jet fuel produced and ready for transport to the end user*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_ECF_Kerosene_JetFuel_Refinery_2011.02.xls*, which provides additional details regarding relevant calculations, data quality, and references.

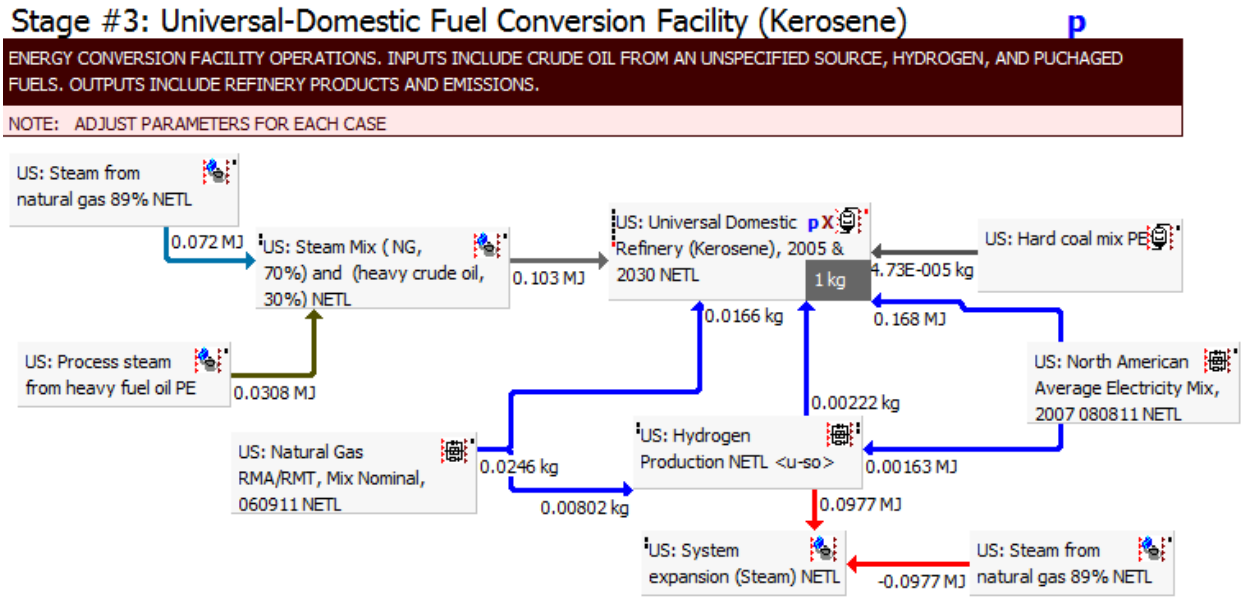
Goal and Scope

The scope of this unit process covers all aspects of the energy conversion facility (ECF) in support of kerosene jet fuel production prior to transport of the finished fuel to the end user. This process is applicable only to kerosene jet fuels produced at the ECF. Other types of fuels produced at the ECF, including gasoline and diesel fuel, are treated in separate processes. This process evaluates inputs and environmental flows associated with fuel refining, as shown in **Figure 1**. At the downstream boundary of the process, one kilogram of finished fuel is delivered to the life cycle (LC) Stage #4 boundary. LC Stages #1 and #2 (raw materials acquisition and raw materials transport) are treated separately in separate unit processes and associated documentation.

Boundary and Description

LC Stage #3, energy conversion in support of petroleum-based kerosene jet fuel production, includes all operation procedures required for the production of kerosene jet fuel from crude oil. Refinery construction and commissioning/decommissioning are not included within the scope of this process. Within refinery operation, upstream processes (i.e., hard coal, hydrogen, and steam) are included. The plan for the ECF for petroleum-based kerosene jet fuel is provided in **Figure 1**.

Figure 1: Plan Petroleum Based Kerosene Jet Fuels Energy Conversion Facility



Energy conversion in support of kerosene jet fuel production is comprised of a single facility operations unit process, as shown below. Therefore, no assembly process is required, and linkages with other processes are non-existent within LC Stage #3. The single operation unit process for the conversion facility operation requires crude oil, steam, and hydrogen gas as primary inputs, and calculates emissions resulting from the refining process. All allocation for the refinery is calculated within the operations unit process. As noted previously, construction and commissioning/decommissioning are not considered. The following unit process is included for the kerosene jet fuel ECF:

- Kerosene jet fuel Refinery Operations
  (DS/DF_Stage3_O_Petroleum_Refinery_2010.02.doc)

The profiles included for the ECF in support of petroleum-based kerosene jet fuel production are provided in **Table 1**. Those shown in bold face were developed by NETL.

Table 1: Profiles and Processes Included in ECF for Petroleum Based Kerosene Jet Fuel

Stage #3: Universal-Domestic Fuel Conversion Facility (Gasoline)
North American Average Electricity Mix, 2007 070111 NETL
US: Hard coal mix PE
US: Hydrogen Production NETL <u-so>
US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL
US: Process steam from heavy fuel oil PE
US: Steam from natural gas 89% NETL
US: Steam from natural gas 89% NETL

US: Steam Mix (NG, 70%) and (heavy crude oil, 30%) NETL

US: System expansion (Steam) NETL

US: Universal Domestic Refinery (Kerosene), 2005&2030 NETL

Parameters and Balances

The parameters for the highest level modeling plans for the petroleum kerosene jet fuel ECF 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 ECF model plan.

Table 2: Adjustable Parameters for Petroleum Based Kerosene Jet Fuel ECF

Plan	Parameter	Value	Comment
LC Stage #1			
Stage #3: Petroleum Based Kerosene Jet Fuel Energy Conversion Facility	S3_DELTA_GHGA	0.000809	[dimensionless] Adjustable parameter; adjusts refinery CO2 emissions per change in crude oil source (e.g., 0.0 = no change; 0.2 = 20% increase)
Stage #3: Petroleum Based Kerosene Jet Fuel Energy Conversion Facility	S3_FENERGY	0.0612	[dimensionless] Fraction of refinery energy attributable to a chosen refinery product (kerosene jet fuel)
Stage #3: Petroleum Based Kerosene Jet Fuel Energy Conversion Facility	S3_FH2	0.0902	[dimensionless] Fraction of refinery hydrogen attributable to a chosen refinery product (kerosene jet fuel)
Stage #3: Petroleum Based Kerosene Jet Fuel Energy Conversion Facility	S3_RHO_BBL	128	[kg/bbl] density of refinery product (based on specific gravity of input crude)

Table 3: Inputs and Output Balances for Gate-to-Gate Petroleum Based Kerosene Jet Fuel ECF (kg/kg produced)

Process or Category	Gate to Gate (ECF)
Inputs	
Flows	2.029E+00
Resources	2.029E+00
Energy resources	3.473E-02
Non renewable energy resources	3.473E-02
Crude oil (resource)	1.295E-03
Crude oil Algeria	7.642E-06
Crude oil Angola	2.530E-05
Crude oil Argentina	5.335E-06
Crude oil Australia	4.815E-06
Crude oil Austria	3.163E-07
Crude oil Bolivia	4.915E-12

Process or Category	Gate to Gate (ECF)
Crude oil Brazil	4.838E-06
Crude oil Brunei	3.248E-10
Crude oil Bulgaria	2.097E-11
Crude oil Cameroon	2.116E-06
Crude oil Canada	1.043E-04
Crude oil Chile	8.423E-11
Crude oil China	1.351E-06
Crude oil CIS	5.316E-05
Crude oil Colombia	1.739E-05
Crude oil Czech Republic	2.121E-08
Crude oil Denmark	9.992E-06
Crude oil Ecuador	7.740E-06
Crude oil Egypt	1.296E-06
Crude oil France	4.765E-07
Crude oil Gabon	1.245E-05
Crude oil Germany	1.754E-06
Crude oil Greece	6.304E-08
Crude oil Hungary	2.573E-10
Crude oil India	1.995E-11
Crude oil Indonesia	3.979E-06
Crude oil Iran	9.112E-06
Crude oil Iraq	3.932E-05
Crude oil Ireland	1.934E-12
Crude oil Italy	2.033E-06
Crude oil Kuwait	1.725E-05
Crude oil Libya	1.452E-05
Crude oil Malaysia	1.597E-10
Crude oil Mexico	1.084E-04
Crude oil Netherlands	1.293E-06
Crude oil New Zealand	9.783E-08
Crude oil Nigeria	4.815E-05
Crude oil Norway	6.528E-05
Crude oil Oman	1.201E-06
Crude oil Poland	8.110E-08
Crude oil Qatar	6.790E-07
Crude oil Romania	1.265E-07

Process or Category	Gate to Gate (ECF)
Crude oil Saudi Arabia	1.245E-04
Crude oil Slovakia	1.450E-12
Crude oil South Africa	2.521E-12
Crude oil Spain	1.050E-07
Crude oil Syria	1.198E-10
Crude oil Trinidad and Tobago	4.744E-06
Crude oil Tunisia	5.899E-07
Crude oil Turkey	4.418E-16
Crude oil United Arab Emirates	8.284E-07
Crude oil United Kingdom	8.363E-05
Crude oil USA	4.018E-04
Crude oil Venezuela	1.067E-04
Hard coal (resource)	7.919E-03
Hard coal Australia	1.125E-05
Hard coal Belgium	9.644E-09
Hard coal Bosnia and Herzegovina	1.778E-09
Hard coal Brazil	1.880E-08
Hard coal Canada	4.563E-05
Hard coal Chile	8.807E-09
Hard coal China	1.375E-06
Hard coal CIS	2.147E-06
Hard coal Colombia	7.611E-05
Hard coal Czech Republic	4.721E-07
Hard coal France	1.919E-07
Hard coal Germany	1.025E-05
Hard coal India	9.645E-10
Hard coal Indonesia	1.542E-05
Hard coal Italy	2.162E-10
Hard coal Japan	2.982E-12
Hard coal Malaysia	5.587E-12
Hard coal Mexico	8.735E-08
Hard coal New Zealand	7.209E-09
Hard coal Poland	3.754E-06
Hard coal Portugal	1.046E-11
Hard coal South Africa	8.770E-06
Hard coal Spain	2.414E-07

Process or Category	Gate to Gate (ECF)
Hard coal Turkey	2.180E-12
Hard coal United Kingdom	2.371E-06
Hard coal USA	7.713E-03
Hard coal Venezuela	2.737E-05
Hard coal Vietnam	5.560E-08
Lignite (resource)	3.750E-04
Lignite Australia	2.215E-06
Lignite Austria	4.080E-08
Lignite Bosnia and Herzegovina	4.107E-09
Lignite Bulgaria	2.398E-09
Lignite Canada	8.810E-06
Lignite CIS	4.386E-08
Lignite Czech Republic	2.423E-07
Lignite France	5.117E-08
Lignite Germany (Central Germany)	3.198E-05
Lignite Germany (Lausitz)	9.194E-06
Lignite Germany (Rheinisch)	1.780E-05
Lignite Greece	7.574E-08
Lignite Hungary	1.219E-08
Lignite India	1.930E-10
Lignite Macedonia	5.508E-09
Lignite Poland	1.422E-07
Lignite Romania	6.198E-10
Lignite Serbia and Montenegro	3.197E-08
Lignite Slovakia	1.900E-09
Lignite Slovenia	1.047E-08
Lignite Spain	5.087E-07
Lignite Turkey	5.475E-14
Lignite USA	3.038E-04
Natural gas (resource)	2.514E-02
Natural gas Algeria	3.455E-05
Natural gas Angola	3.224E-06
Natural gas Argentina	5.653E-07
Natural gas Australia	5.460E-07
Natural gas Austria	4.161E-08
Natural gas Bolivia	9.878E-09

Process or Category	Gate to Gate (ECF)
Natural gas Brazil	5.742E-07
Natural gas Brunei	2.810E-06
Natural gas Bulgaria	1.758E-12
Natural gas Cameroon	5.272E-07
Natural gas Canada	4.216E-03
Natural gas Chile	2.004E-08
Natural gas China	1.537E-07
Natural gas CIS	1.110E-05
Natural gas Colombia	1.895E-06
Natural gas Czech Republic	1.609E-09
Natural gas Denmark	1.053E-06
Natural gas Ecuador	8.622E-07
Natural gas Egypt	1.309E-07
Natural gas France	9.454E-08
Natural gas Gabon	1.839E-06
Natural gas Germany	5.571E-06
Natural gas Greece	4.235E-09
Natural gas Hungary	6.445E-10
Natural gas India	7.461E-11
Natural gas Indonesia	2.086E-07
Natural gas Iran	1.041E-06
Natural gas Iraq	3.963E-06
Natural gas Ireland	4.319E-09
Natural gas Italy	2.579E-07
Natural gas Japan	9.517E-13
Natural gas Kuwait	1.665E-06
Natural gas Libyan	3.965E-07
Natural gas Malaysia	2.796E-06
Natural gas Mexico	1.436E-05
Natural gas Netherlands	8.621E-06
Natural gas New Zealand	6.478E-09
Natural gas Nigeria	2.093E-05
Natural gas Norway	6.789E-06
Natural gas Oman	2.919E-06
Natural gas Poland	5.710E-09
Natural gas Qatar	4.224E-05

Process or Category	Gate to Gate (ECF)
Natural gas Romania	8.113E-09
Natural gas Saudi Arabia	1.166E-05
Natural gas Slovakia	1.529E-11
Natural gas South Africa	1.916E-09
Natural gas Spain	1.444E-08
Natural gas Syria	1.287E-11
Natural gas Trinidad and Tobago	1.820E-04
Natural gas Tunisia	7.724E-08
Natural gas Turkey	4.468E-17
Natural gas United Arab Emirates	9.341E-08
Natural gas United Kingdom	8.840E-06
Natural gas USA	2.051E-02
Natural gas Venezuela	1.028E-05
Pit Methane	3.005E-05
Uranium (resource)	1.970E-07
Uranium natural	1.970E-07
Renewable energy resources	1.421E-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 wind power	0.000E+00
Wood	1.421E-07
Land use	0.000E+00
Occupation	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
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	1.994E+00

Process or Category	Gate to Gate (ECF)
Non renewable elements	2.854E-12
Iron	7.123E-14
Lead	1.048E-17
Sulphur	2.783E-12
Non renewable resources	5.368E-02
Barium sulphate	1.074E-15
Basalt	2.090E-06
Bauxite	3.302E-07
Bentonite	2.015E-04
Calcium chloride	1.100E-13
Chromium ore (39%)	3.351E-08
Clay	1.202E-05
Colemanite ore	3.430E-09
Copper - Gold - Silver - ore (1,0% Cu; 0,4 g/t Au; 66 g/t Ag)	1.039E-07
Copper - Gold - Silver - ore (1,1% Cu; 0,01 g/t Au; 2,86 g/t Ag)	6.329E-08
Copper - Gold - Silver - ore (1,16% Cu; 0,002 g/t Au; 1,06 g/t Ag)	3.573E-08
Copper - Molybdenum - Gold - Silver - ore (1,13% Cu; 0,02% Mo; 0,01 g/t Au; 2,86 g/t Ag)	8.704E-08
Copper ore (0.14%)	7.667E-07
Copper ore (1.2%)	1.077E-08
Copper ore (4%)	7.966E-17
Copper ore (sulphidic, 1.1%)	9.452E-14
Dolomite	1.133E-09
Ferro manganese	5.240E-18
Fluorspar (calcium fluoride; fluorite)	7.284E-10
Gypsum (natural gypsum)	7.769E-06
Heavy spar (BaSO4)	4.874E-04
Inert rock	5.193E-02
Iron ore (56,86%)	1.515E-04
Iron ore (65%)	1.075E-08
Kaolin ore	6.103E-09
Lead - zinc ore (4.6%-0.6%)	3.919E-05
Limestone (calcium carbonate)	6.696E-04
Magnesit (Magnesium carbonate)	1.531E-10
Magnesium chloride leach (40%)	4.932E-06
Manganese ore	6.678E-09
Manganese ore (R.O.M.)	1.523E-06

Process or Category	Gate to Gate (ECF)
Molybdenite (Mo 0,24%)	5.356E-08
Natural Aggregate	1.243E-04
Nickel ore (1,5%)	9.504E-12
Nickel ore (1.6%)	5.397E-06
Olivine	5.764E-17
Peat	2.607E-07
Phosphate ore	5.907E-11
Phosphorus minerals	1.526E-10
Potassium chloride	6.922E-11
Precious metal ore (R.O.M)	2.693E-09
Quartz sand (silica sand; silicon dioxide)	2.652E-06
Raw pumice	5.928E-10
Slate	9.693E-17
Sodium chloride (rock salt)	2.306E-07
Sodium sulphate	7.614E-13
Soil	2.905E-05
Sulphur (bonded)	1.391E-12
Talc	1.650E-10
Tin ore	9.316E-17
Titanium ore	5.452E-07
Zinc - copper ore (4.07%-2.59%)	6.727E-06
Zinc - lead - copper ore (12%-3%-2%)	2.753E-06
Zinc - lead ore (4.21%-4.96%)	2.720E-17
Zinc ore (sulphidic, 4%)	1.630E-16
Renewable resources	1.940E+00
Water	1.793E+00
Water	1.541E+00
Water (ground water)	1.015E-02
Water (river water)	0.000E+00
Water (sea water)	0.000E+00
Water (surface water)	2.419E-01
Air	1.471E-01
Carbon dioxide	1.515E-04
Nitrogen	1.788E-12
Oxygen	2.215E-07
Output	

Process or Category	Gate to Gate (ECF)
Flows	6.165E-01
Resources	1.814E-01
Material resources	1.814E-01
Renewable resources	1.814E-01
Water	1.814E-01
Water (river water)	1.813E-01
Water (sea water)	5.478E-05
Emissions to air	4.259E-01
Heavy metals to air	3.665E-08
Antimony	2.286E-10
Arsenic (+V)	2.841E-09
Arsenic trioxide	2.713E-14
Cadmium (+II)	1.518E-10
Chromium (+III)	6.041E-12
Chromium (unspecified)	2.887E-10
Cobalt	1.662E-10
Copper (+II)	3.527E-10
Heavy metals to air (unspecified)	1.561E-12
Hydrogen arsenic (arsine)	2.252E-12
Iron	1.979E-10
Lanthanides	1.792E-14
Lead (+II)	2.826E-09
Manganese (+II)	7.665E-10
Mercury (+II)	3.971E-10
Molybdenum	1.315E-11
Nickel (+II)	1.697E-09
Palladium	3.044E-18
Rhodium	2.938E-18
Selenium	6.576E-09
Silver	5.250E-19
Tellurium	8.055E-13
Thallium	5.906E-12
Tin (+IV)	2.485E-09
Titanium	1.337E-12
Vanadium (+III)	1.403E-08
Zinc (+II)	3.614E-09

Process or Category	Gate to Gate (ECF)
Inorganic emissions to air	3.049E-01
Ammonia	2.260E-06
Ammonium	8.233E-14
Ammonium nitrate	8.120E-15
Barium	3.111E-07
Beryllium	3.819E-11
Boron compounds (unspecified)	4.600E-08
Bromine	1.957E-08
Carbon dioxide	2.385E-01
Carbon dioxide (biotic)	5.212E-05
Carbon disulphide	1.198E-13
Carbon monoxide	9.628E-05
Chloride (unspecified)	1.258E-09
Chlorine	3.160E-13
Cyanide (unspecified)	8.455E-11
Fluoride	5.380E-09
Fluorides	-3.877E-12
Fluorine	6.581E-13
Helium	1.386E-10
Hydrogen	1.821E-08
Hydrogen bromine (hydrobromic acid)	1.439E-11
Hydrogen chloride	2.005E-07
Hydrogen cyanide (prussic acid)	3.883E-12
Hydrogen fluoride	3.317E-08
Hydrogen iodide	9.412E-15
Hydrogen phosphorous	5.428E-15
Hydrogen sulphide	2.356E-07
Lead dioxide	5.482E-15
Nitrogen (atmospheric nitrogen)	9.659E-06
Nitrogen dioxide	1.266E-04
Nitrogen monoxide	1.047E-12
Nitrogen oxides	6.839E-05
Nitrous oxide (laughing gas)	3.682E-06
Oxygen	1.071E-04
Scandium	7.762E-15
Steam	6.558E-02

Process or Category	Gate to Gate (ECF)
Strontium	3.238E-13
Sulphur dioxide	3.195E-04
Sulphur hexafluoride	3.798E-13
Sulphuric acid	1.468E-10
Tin oxide	4.770E-16
Zinc oxide	9.540E-16
Zinc sulphate	5.659E-11
Organic emissions to air (group VOC)	3.964E-04
Group NMVOC to air	1.034E-04
Group PAH to air	2.087E-09
Anthracene	5.644E-12
Benzo{a}anthracene	2.840E-12
Benzo{a}pyrene	3.820E-12
Benzo{ghi}perylene	2.533E-12
Benzofluoranthene	5.067E-12
Chrysene	6.976E-12
Dibenz(a)anthracene	1.579E-12
Indeno[1,2,3-cd]pyrene	1.885E-12
Naphthalene	5.927E-10
Phenanthrene	1.862E-10
Polycyclic aromatic hydrocarbons (PAH)	1.278E-09
Halogenated organic emissions to air	3.805E-09
Dichloromethane (methylene chloride)	4.253E-17
Dioxins (unspec.)	2.182E-16
Halogenated hydrocarbons (unspecified)	2.099E-17
Polychlorinated biphenyls (PCB unspecified)	4.935E-12
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	1.480E-15
R 11 (trichlorofluoromethane)	1.446E-09
R 114 (dichlorotetrafluoroethane)	1.480E-09
R 12 (dichlorodifluoromethane)	3.108E-10
R 13 (chlorotrifluoromethane)	1.951E-10
R 22 (chlorodifluoromethane)	3.397E-10
Tetrafluoromethane	5.351E-12
Vinyl chloride (VCM; chloroethene)	2.293E-11
Acetaldehyde (Ethanal)	4.972E-09
Acetic acid	2.116E-08

Process or Category	Gate to Gate (ECF)
Acetone (dimethylcetone)	4.923E-09
Acrolein	3.983E-11
Aldehyde (unspecified)	5.176E-10
Alkane (unspecified)	1.224E-07
Alkene (unspecified)	1.046E-07
Aromatic hydrocarbons (unspecified)	1.869E-09
Benzene	1.316E-08
Butadiene	8.118E-14
Butane	1.425E-06
Butane (n-butane)	2.752E-08
Cyclohexane (hexahydro benzene)	2.746E-12
Diethylamine	2.058E-18
Ethane	5.265E-06
Ethanol	1.032E-08
Ethene (ethylene)	8.140E-11
Ethyl benzene	1.037E-07
Fluoranthene	1.838E-11
Fluorene	5.833E-11
Formaldehyde (methanal)	5.928E-08
Heptane (isomers)	2.806E-09
Hexamethylene diamine (HMDA)	4.775E-15
Hexane (isomers)	4.545E-09
Mercaptan (unspecified)	3.017E-10
Methanol	9.398E-09
NMVOC (unspecified)	9.080E-05
Octane	1.543E-09
Pentane (n-pentane)	7.275E-07
Phenol (hydroxy benzene)	3.592E-13
Propane	4.149E-06
Propene (propylene)	9.424E-09
Propionic acid (propane acid)	6.772E-12
Styrene	3.041E-15
Toluene (methyl benzene)	4.866E-08
Trimethylbenzene	4.647E-15
Xylene (dimethyl benzene)	4.345E-07
Methane	2.930E-04

Process or Category	Gate to Gate (ECF)
Organic chlorine compounds	4.088E-15
VOC (unspecified)	7.369E-08
Other emissions to air	1.206E-01
Exhaust	1.205E-01
non used primary energy from wind power	0.000E+00
Particulate Matter, unspecified	2.056E-05
Unused primary energy from solar energy	0.000E+00
Used air	1.202E-04
Waste heat	0.000E+00
Particles to air	5.463E-06
Dust (PM10)	3.585E-07
Dust (PM2.5)	1.819E-06
Dust (unspecified)	3.285E-06
Metals (unspecified)	3.300E-14
Wood (dust)	1.761E-13
Radioactive emissions to air	1.693E-09
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
Krypton (Kr85)	0.000E+00
Krypton (Kr85m)	0.000E+00
Plutonium (Pu alpha)	0.000E+00
Radon (Rn222)	0.000E+00
Uranium (total)	1.693E-09
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

Process or Category	Gate to Gate (ECF)
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	9.125E-03
Analytical measures to fresh water	1.556E-05
Adsorbable organic halogen compounds (AOX)	2.433E-09
Biological oxygen demand (BOD)	5.470E-07
Chemical oxygen demand (COD)	1.419E-05
Solids (dissolved)	2.470E-07
Total dissolved organic bounded carbon	2.837E-13
Total organic bounded carbon	5.724E-07
Heavy metals to fresh water	2.172E-03
Antimony	4.359E-06
Arsenic (+V)	1.393E-05
Cadmium (+II)	1.343E-06
Chromium (+III)	3.817E-10
Chromium (+VI)	3.383E-18
Chromium (unspecified)	2.411E-05
Cobalt	3.021E-12
Copper (+II)	2.020E-05
Heavy metals to water (unspecified)	1.945E-11
Iron	1.034E-03
Lead (+II)	4.715E-05
Manganese (+II)	2.205E-08
Mercury (+II)	2.367E-07
Molybdenum	4.213E-09
Nickel (+II)	3.737E-04
Selenium	7.231E-10
Silver	4.251E-06
Strontium	6.000E-08
Thallium	9.512E-13
Tin (+IV)	9.667E-12
Titanium	4.487E-10
Vanadium (+III)	1.310E-09

Process or Category	Gate to Gate (ECF)
Zinc (+II)	6.487E-04
Inorganic emissions to fresh water	6.501E-03
Acid (calculated as H+)	3.522E-10
Aluminum (+III)	4.917E-04
Ammonia	5.325E-03
Ammonium / ammonia	1.208E-07
Barium	1.260E-09
Beryllium	5.073E-12
Boron	5.016E-08
Bromine	7.320E-13
Calcium (+II)	7.793E-06
Carbonate	6.288E-08
Chloride	1.012E-04
Chlorine (dissolved)	1.834E-07
Cyanide	3.956E-05
Fluoride	2.261E-05
Fluorine	3.083E-10
Hydrogen chloride	6.115E-12
Hydrogen fluoride (hydrofluoric acid)	1.030E-12
Hydroxide	1.772E-10
Magnesium (+III)	1.636E-06
Magnesium chloride	8.281E-13
Neutral salts	1.093E-17
Nitrate	7.942E-07
Nitrogen	1.059E-10
Nitrogen organic bounded	1.052E-08
Phosphate	2.399E-09
Phosphorus	4.697E-04
Potassium	7.285E-10
Silicate particles	1.225E-12
Sodium (+I)	1.398E-05
Sodium chloride (rock salt)	2.085E-12
Sodium hypochlorite	1.952E-13
Sulphate	2.727E-05
Sulphide	1.058E-08
Sulphite	1.505E-08

Process or Category	Gate to Gate (ECF)
Sulphur	2.704E-10
Sulphuric acid	7.883E-10
Organic emissions to fresh water	6.634E-07
Halogenated organic emissions to fresh water	6.303E-12
1,2-Dibromoethane	6.451E-16
Chlorinated hydrocarbons (unspecified)	9.465E-18
Chloromethane (methyl chloride)	6.299E-12
Dichloropropane	3.833E-18
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	1.019E-22
Vinyl chloride (VCM; chloroethene)	3.125E-15
Hydrocarbons to fresh water	5.730E-08
Acenaphthene	2.171E-13
Acenaphthylene	8.556E-14
Acetic acid	1.266E-10
Acrylonitrile	2.803E-13
Anthracene	2.409E-13
Aromatic hydrocarbons (unspecified)	5.499E-09
Benzene	3.825E-10
Benzo{a}anthracene	3.506E-14
Benzofluoranthene	2.762E-14
Chrysene	1.748E-13
Cresol (methyl phenol)	7.003E-12
Ethyl benzene	2.101E-11
Fluoranthene	5.062E-14
Hexane (isomers)	7.649E-13
Hydrocarbons (unspecified)	1.572E-09
Methanol	2.567E-08
Oil (unspecified)	2.156E-08
Phenol (hydroxy benzene)	3.707E-10
Polycyclic aromatic hydrocarbons (PAH, unspec.)	1.529E-09
Toluene (methyl benzene)	2.654E-10
Xylene (isomers; dimethyl benzene)	2.822E-10
Carbon, organically bound	6.061E-07
Naphthalene	1.138E-11
Organic chlorine compounds (unspecified)	4.247E-15
Organic compounds (dissolved)	1.737E-14

Process or Category	Gate to Gate (ECF)
Organic compounds (unspecified)	1.583E-25
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	4.356E-04
Metals (unspecified)	1.885E-13
Soil loss by erosion into water	1.593E-11
Solids (suspended)	4.356E-04
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
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	8.694E-05
Analytical measures to sea water	9.134E-07
Adsorbable organic halogen compounds (AOX)	6.735E-14
Biological oxygen demand (BOD)	7.429E-08
Chemical oxygen demand (COD)	7.648E-07
Total organic bounded carbon	7.429E-08
Heavy metals to sea water	1.960E-08

Process or Category	Gate to Gate (ECF)
Arsenic (+V)	2.839E-10
Cadmium (+II)	1.170E-09
Chromium (unspecified)	1.275E-09
Cobalt	8.659E-11
Copper (+II)	4.360E-09
Iron	1.318E-09
Lead (+II)	9.715E-10
Manganese (+II)	1.363E-10
Mercury (+II)	2.281E-11
Molybdenum	1.975E-12
Nickel (+II)	1.183E-09
Silver	5.861E-12
Strontium	6.241E-09
Tin (+IV)	7.020E-12
Titanium	7.151E-13
Vanadium (+III)	6.027E-11
Zinc (+II)	2.473E-09
Inorganic emissions to sea water	2.687E-05
Aluminum (+III)	2.302E-11
Ammonia	6.841E-10
Barium	4.538E-09
Beryllium	4.839E-12
Boron	3.722E-10
Calcium (+II)	4.065E-08
Carbonate	2.855E-07
Chloride	2.485E-05
Magnesium	2.278E-08
Nitrate	3.701E-10
Sodium (+I)	1.484E-06
Sulphate	1.223E-07
Sulphide	5.196E-08
Sulphur	1.992E-10
Organic emissions to sea water	1.683E-08
Hydrocarbons to sea water	1.670E-08
Acenaphthene	4.028E-12
Acenaphthylene	1.526E-12

Process or Category	Gate to Gate (ECF)
Acetic acid	7.109E-12
Anthracene	1.516E-12
Aromatic hydrocarbons (unspecified)	7.429E-10
Benzene	1.157E-09
Benzo{a}anthracene	8.631E-13
Benzofluoranthene	9.393E-13
Chrysene	4.832E-12
Cresol (methyl phenol)	5.159E-12
Ethyl benzene	1.021E-10
Fluoranthene	1.087E-12
Hexane (isomers)	5.633E-13
Oil (unspecified)	1.157E-08
Phenol (hydroxy benzene)	1.897E-09
Toluene (methyl benzene)	6.822E-10
Xylene (isomers; dimethyl benzene)	5.202E-10
Naphthalene	1.356E-10
Particles to sea water	5.913E-05
Solids (suspended)	5.913E-05
Emissions to industrial soil	7.034E-07
Heavy metals to industrial soil	1.990E-07
Arsenic (+V)	1.874E-13
Cadmium (+II)	2.348E-12
Chromium (+III)	5.808E-14
Chromium (unspecified)	3.962E-10
Cobalt	6.915E-12
Copper (+II)	3.147E-12
Iron	4.999E-10
Lead (+II)	1.716E-13
Manganese (+II)	9.339E-11
Mercury (+II)	6.579E-15
Nickel (+II)	1.391E-10
Strontium	1.978E-07
Zinc (+II)	3.843E-11
Inorganic emissions to industrial soil	4.961E-07
Aluminum (+III)	3.896E-10
Ammonia	2.919E-07

Process or Category	Gate to Gate (ECF)
Bromide	5.926E-11
Calcium (+II)	5.639E-09
Chloride	6.946E-08
Fluoride	1.975E-09
Magnesium (+III)	7.802E-10
Phosphorus	3.217E-08
Potassium (+I)	3.936E-08
Sodium (+I)	4.931E-10
Sulphate	7.693E-09
Sulphide	4.616E-08
Organic emissions to industrial soil	8.285E-09
Oil (unspecified)	8.285E-09

Embedded Unit Processes

NETL (2010). NETL Life Cycle Inventory Data – Unit Process: Petroleum Refinery. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: May 2012 (version 02). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

References

None.

Section III: Document Control Information

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