NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Broadcast Burning Crownwood

Reference Flow: 1 kg of Crownwood, broadcast burned

Brief Description: Air emissions from the combustion of stemwood that is broadcast burned

Section I: Meta Data

Geographical Coverage: United States **Region:** Inland West

Year Data Best Represents: N/A

Process Type: Auxiliary Process (AP)

Process Scope: Gate-to-Grave (End-of-Life) Process (GE)

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	☑ Other
Releases to Water:	☐ Inorganic	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☐ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

crown_flame	*[dimensionless] Fraction of crown that combusts in flame phase*
crown_smolder	*[dimensionless] Fraction of crown that combusts in smoldering phase*
crown_residual	*[dimensionless] Fraction of crown that combusts in residual phase*
dry_frac	*[dimensionless] Fraction of wood that that is dry forest*

ef_pm_dry_fl	*[kg/kg] Emission factor for PM in flame phase for dry forest*
ef_pm10_dry_fl	*[kg/kg] Emission factor for PM10 in flame phase for dry forest*
ef_pm25_dry_fl	*[kg/kg] Emission factor for PM2.5 in flame phase for dry forest*
ef_co_dry_fl	*[kg/kg] Emission factor for CO in flame phase for dry forest*
ef_co2_dry_fl	*[kg/kg] Emission factor for CO_2 in flame phase for dry forest*
ef_ch4_dry_fl	*[kg/kg] Emission factor for CH_4 in flame phase for dry forest*
ef_nmhc_dry_fl	*[kg/kg] Emission factor for non-methane hydrocarbons in flame phase for dry forest*
ef_ec_dry_fl	*[kg/kg] Emission factor for elemental carbon in flame phase for dry forest*
ef_oc_dry_fl	*[kg/kg] Emission factor for organic carbon in flame phase for dry forest*
ef_nox_dry_fl	*[kg/kg] Emission factor for NOx in flame phase for dry forest*
ef_nh3_dry_fl	*[kg/kg] Emission factor for NH_3 in flame phase for dry forest*
ef_voc_dry_fl	*[kg/kg] Emission factor for VOCs in flame phase for dry forest*
ef_so2_dry_fl	*[kg/kg] Emission factor for SO_2 in flame phase for dry forest*
ef_meth_dry_fl	*[kg/kg] Emission factor for methanol in flame phase for dry forest*
ef_form_dry_fl	*[kg/kg] Emission factor for formaldehyde in flame phase for dry forest*
ef_pm_dry_sm	*[kg/kg] Emission factor for PM in smoldering or residual phases for dry forest*
ef_pm10_dry_sm	*[kg/kg] Emission factor for PM10 in smoldering or residual phases for dry forest*

ef_pm25_dry_sm	*[kg/kg] Emission factor for PM2.5 in smoldering or residual phases for dry forest*
ef_co_dry_sm	*[kg/kg] Emission factor for CO in smoldering or residual phases for dry forest*
ef_co2_dry_sm	*[kg/kg] Emission factor for CO_2 in smoldering or residual phases for dry forest*
ef_ch4_dry_sm	*[kg/kg] Emission factor for CH_4 in smoldering or residual phases for dry forest*
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ef_meth_dry_sm	*[kg/kg] Emission factor for methanol in smoldering or residual phases for dry forest*
ef_form_dry_sm	*[kg/kg] Emission factor for formaldehyde in smoldering or residual phases for dry forest*

ef_pm_wet_fl	*[kg/kg] Emission factor for PM in flame phase for moist forest*
ef_pm10_wet_fl	*[kg/kg] Emission factor for PM10 in flame phase for moist forest*
ef_pm25_wet_fl	*[kg/kg] Emission factor for PM2.5 in flame phase for moist forest*
ef_co_wet_fl	*[kg/kg] Emission factor for CO in flame phase for moist forest*
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ef_voc_wet_sm	*[kg/kg] Emission factor for VOCs in smoldering or residual phases for moist forest*
ef_so2_wet_sm	*[kg/kg] Emission factor for SO_2 in smoldering or residual phases for moist forest*
ef_meth_wet_sm	*[kg/kg] Emission factor for methanol in smoldering or residual phases for moist forest*
ef_form_wet_sm	*[kg/kg] Emission factor for formaldehyde in smoldering or residual phases for moist forest*

Tracked Input Flows:

Tracked Output Flows:

Crownwood, broadcast burned [Insert]	*Reference flow*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_Broadcast_Burning_Crownwood_2013.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

This unit process provides a summary of relevant input and output flows associated with broadcast burning crownwood. The reference flow of this unit process is: 1 kg of Crownwood, broadcast burned

Boundary and Description

Crownwood that is broadcast burned produces a number of atmospheric emissions that may cause human health and environmental impacts. Emissions depend on if the wood is burning with a flame or smoldering. Additionally, some fraction of the crownwood may not burn, and will end up as residue. For crownwood, 90 percent burns with a flame, 10 percent smolders, and none ends up as residual.

Broadcast burning is typically practiced in national forests. This unit process can account for either moist or dry conditions, represented by emissions from mixed conifer or ponderosa/lodgpole trees. The default value is for a 50/50 mix when the type of forest is not known.

Figure 1: Unit Process Scope and Boundary

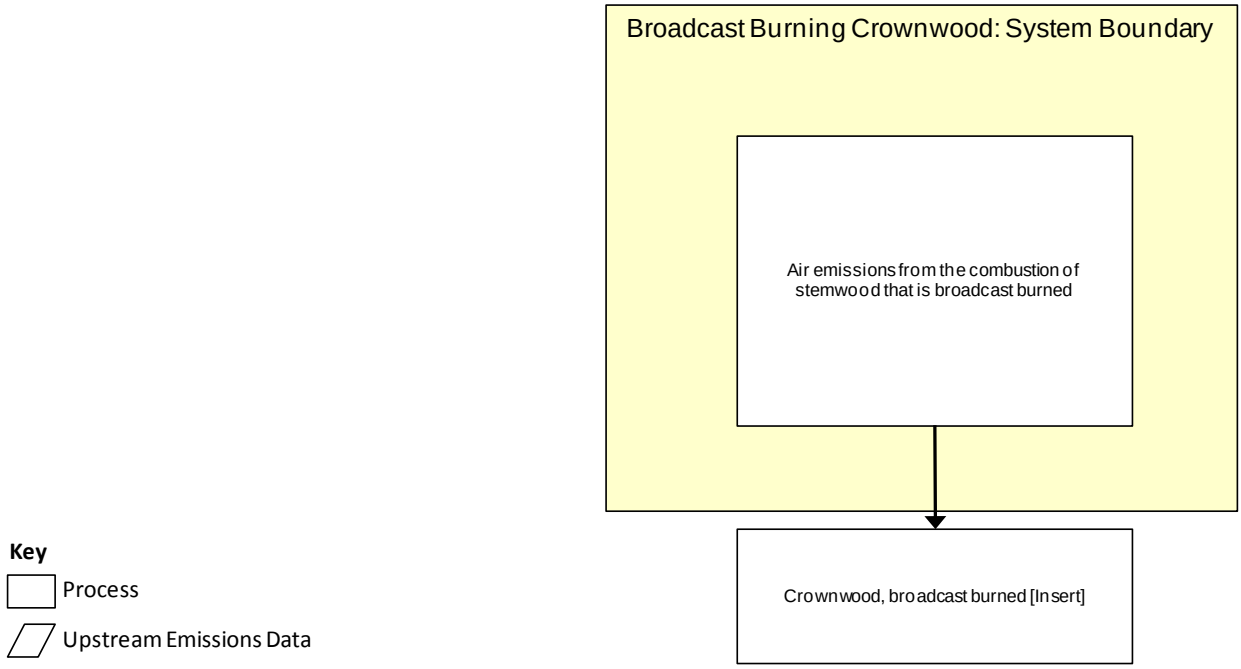

Table 1: Dry Crownwood Broadcast Combustion Factors

Emission Species	Flame (kg/dry kg)	Smolder (kg/dry kg)
PM	9.40E-03	2.43E-02
PM10	5.75E-03	1.84E-02
PM2.5	5.00E-03	1.71E-02
CO	4.45E-02	1.43E-01
CO2	1.70E+00	1.49E+00
CH4	1.50E-03	7.30E-03
NMHC	1.80E-03	4.80E-03
Elemental Carbon	3.60E-04	1.23E-03
Organic Carbon	2.70E-03	9.23E-03
NOx	2.50E-03	2.50E-03
NH3	3.25E-04	1.04E-03
VOC	3.78E-03	1.21E-02
SO2	8.30E-04	8.30E-04
Methanol	4.41E-04	1.41E-03
Formaldehyde	7.12E-04	2.28E-03

Table 2: Wet Crownwood Broadcast Combustion Factors

Emission Species	Flame (kg/dry kg)	Smolder (kg/dry kg)
PM	1.10E-02	1.68E-02
PM10	5.85E-03	1.27E-02
PM2.5	4.80E-03	1.18E-02
CO	2.65E-02	1.37E-01
CO2	1.73E+00	1.51E+00
CH4	1.50E-03	8.80E-03
NMHC	1.60E-03	6.60E-03
Elemental Carbon	3.46E-04	8.50E-04
Organic Carbon	2.59E-03	6.37E-03
NOx	2.50E-03	2.50E-03
NH3	1.93E-04	9.96E-04
VOC	2.25E-03	1.16E-02
SO2	8.30E-04	8.30E-04
Methanol	2.62E-04	1.35E-03
Formaldehyde	4.24E-04	2.18E-03

Table 2: Unit Process Input and Output Flows

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Carbon dioxide [Inorganic emissions to air]	1.83	kg
Outputs		
Crownwood, broadcast burned [Insert]	1.00	
Carbon dioxide [Inorganic emissions to air]	1.69	kg
Methane [Organic emissions to air (group VOC)]	2.16E-03	kg
Carbon monoxide [Inorganic emissions to air]	4.59E-02	kg
NMVOC (unspecified) [Group NMVOC to air]	2.10E-03	kg
Dust (unspecified) [Particles to air]	1.12E-02	kg
Dust (PM10) [Particles to air]	6.77E-03	kg
Dust (PM2.5) [Particles to air]	5.86E-03	kg
Elemental carbon [emission to air]	4.22E-04	kg
Organic carbon [emission to air]	3.16E-03	kg
Nitrogen oxides [Inorganic emissions to air]	2.50E-03	kg
Ammonia [Inorganic emissions to air]	3.35E-04	kg
VOC (unspecified) [Organic emissions to air]	3.90E-03	kg
Sulphur dioxide [Inorganic emissions to air]	8.30E-04	kg
Methanol [Group NMVOC to air]	4.54E-04	kg
Formaldehyde (methanal) [Group NMVOC to air]	7.34E-04	kg

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

Embedded Unit Processes

None.

References

Johnson *et al.* 2012 — Johnson, L., Lippke, B., & Oneil, E. (2012). Modeling Biomass Collection and Woods Processing Life-Cycle Analysis. Forest Products Journal, 62(4), 258-272.

Battye *et al.* 2002 — Battye, W and R Battye. 2002. Development of Emissions Inventory Methods for Wildland Fire. Final Report for Environmental Protection Agency, Research Triangle Park, North Carolina. EPA Contract No 68-D-98-046. February. 77p.

Prichard *et al.* 2006 — Prichard, S, R Ottmar and G Anderson. 2006. Consume 3.0 User's Guide. Pacific Wildland Fire Sciences Laboratory, Pacific Northwest Research Station, USDA Forest Service. Seattle, Washington. 231p.

Section III: Document Control Information

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