Fuel Usage (gallons) *= (463.4 pounds per hour x 1 hour per 3600 seconds x 2 seconds x number of engines in the ICAO Engine Exhaust Emissions Databank / 6.84 pounds per gallon) + (829 pounds per hour x 1 hour per 3600 seconds) x 40 seconds x number of engines in the ICAO Engine Exhaust Emissions Databank / 6.84 pounds per gallon)*

Where:

463.4 pounds per hour and 2 seconds is fuel flow rate and duration, respectively, for the first phase of startup.

829 pounds per hour and 40 seconds is fuel flow rate and duration, respectively, for the second phase of startup.

Equation C-4. Aircraft Engine Startup Jet A Fuel Usage

Aircraft engine startup mode is divided into two fractions: (1) the raw fuel released prior to ignition, and (2) the products of incomplete combustion during the acceleration to idle power. The latter fraction contributes the most fuel usage. **Equation C-4** (*Aircraft Engine Startup Jet A Fuel Usage*) presents the fuel usage calculations of Jet A from both fractions in gallons. During the first phase, 463.4 pounds per hour and 2 seconds is fuel flow rate and duration, respectively. During the second phase, 829 pounds per hour and 40 seconds is fuel flow rate and duration, respectively. The other input data is the number of engines.

Once the engine startup fuel usage (in gallons) is determined, **Table C-1** (*GHG Emission Factors for Aircraft Fuel*) and **Equation C-5** (*CO_{2e} Emission Calculation for Turbine Aircraft during Startup*) should be used to determine the CO_2, CH_4, and N_2O emissions, which should then be adjusted to account for GWP with a result of CO_{2e} (in metric tons). **Equation C-5** (*CO_{2e} Emission Calculation for Turbine Aircraft during Startup*) provides an example for Jet A.

CO_2 (metric tons) *= Fuel Usage (gallons) x 21.098 pounds CO_2 per gallon x short ton per 2,000 pound x 0.907185 metric ton per short ton*

CH_4 (metric tons) *= Fuel Usage (gallons) x 0.000595 pounds CH_4 per gallon x short ton per 2,000 pound x 0.907185 metric ton per short ton*

N_2O (metric tons) *= Fuel Usage (gallons) x 0.000683 pounds N_2O per gallon x short ton per 2,000 pound x 0.907185 metric ton per short ton*

CO_{2e} (in metric tons) = CO_2 + CH_4 x 34 + N_2O x 298

Equation C-5. CO_{2e} Emission Calculation for Turbine Aircraft during Startup (Jet A)

C.2.2 Auxiliary Power Units

The following section discusses the methodology for computing GHG emissions from aircraft APUs. APUs consist of small turbine engines used by many commercial jet aircraft to start the