READING: SSME Mathematical Reference

Model Names refer to Main Engine 1.

Vacuum Thrust (*FME*1)

$$FME1 = q \cdot VEME1$$

$$VEME1 = \sqrt{\frac{2K}{K-1} \cdot \frac{R \cdot TC}{M} \cdot \left[1 - \left(\frac{PE}{PC}\right)^{\frac{K-1}{K}}\right]}$$

$$q = \frac{TOTALMASSFLOW}{32.2}$$

where

*FME*1 = Vacuum Thrust
*VEME*1 = Exit Volocity
K = specific heat ratio
R = universal gas constant = 49,720 ft-lb/slog-R
M = molecular weight of combustion in chamber
TC = combustion temperature in chamber = 6,459.69°R
PE = pressure inside combustion chamber = 2,871 psia

Total Mass Flow

$$TOTALMASSFLOW = \frac{RPMFTME1}{33,936} \cdot (151 + 29) + \left(\frac{RPMOTME1}{22,357}\right)\left(67 + 837\left(\frac{MAINXVLVPOSME1}{100}\right)\right)$$

HPFTP

Flow Rate

$$FLOWRATEFTME1 = \frac{FVLVPOSFTME1}{100} \cdot FUELCONSTFTME1 + \frac{OVLVPOSFTME1}{100} \cdot OXBALLVLVCNSTFTME1$$

where

*FVLVPOSFTME*1 = Main Fuel Valve position
*FUELCONSTFTME*1 = Fuel Valve Constant (for fuel flow contribution) = 78
*OVLVPOSFTME*1 = Fuel Pump Turbo Oxidizer Valve position
*OXBALLVLVCNSTFTME*1= Oxidizer Valve Constant (for oxidizer flow contribution) = 68

RPM

$$RPMFTME1 = FLOWRATEFTME1 \cdot FUELPUMPCONSTME1$$

where

*FLOWRATEFTME*1 = HPFTP Flow Rate
*FUELPUMPCONSTME*1 = Fuel Pump Constant = 232.4383562

HPOTP

Flow Rate

$$FLOWRATEOTME1 = \frac{FVLVPOSOTME1}{100} \cdot FUELCONSTOTME1 + \frac{OVLVPOSOTME1}{100} \cdot OXBALLVLVCNSTOTME1$$

where

*FVLVPOSOTME*1 = Fuel Valve position (fuel to HPOTP)
*FUELCONSTFTME*1 = Fuel Valve Constant (for fuel flow contribution) = 40
*OVLVPOSFTME*1 = Oxidizer Pump Turbo Oxidizer Valve position
*OXBALLVLVCNSTFTME*1 = Oxidizer Valve Constant (for oxidizer flow contribution) = 25

RPM

$$RPMOTME1 = \frac{OTURBOFLOWME1}{OXTURBOCONSTME1}$$

where

*OTURBOFLOWME*1 = Liquid Oxygen Flow (demand rate from ET Oxidizer Tank)
*OXTURBOCONSTME*1 = Oxidizer Turbo Constant = 0.04173

LPFTP RPM

$$LOWPRESFRPMME1 = \frac{FTURBOFLOWME1}{155} \cdot 15,761$$

where

*FTURBOFLOWME*1 = LPFTP Flow Rate

LPOTP RPM

$$LOWPRESOXRPMME1 = \frac{OTURBOFLOWME1}{933} \cdot 5,019$$

where

*OTURBOFLOWME*1 = LPOTP Flow Rate