Basic Definitions of Subsystems

NON Payload Rover With Optimistic Solar/Battery Survival Method

```
PayloadMass = 1;
PayloadPower = 1;
PhasedArrayPower = 0;
RadiatorSize = 0.0;
RadiatorMass = 0;
RHUConditionerMass = 0;
RHUIsotopeMass = 0;
RHUPower = 0;
AmtecMass = 0;
GPHSMass = 0;
RTGIsotopeMass = 0;
HotRadiatorMass = 0;
RTGPower = 0;
DeploymentMass = 5;
SolarEfficiency = CosineFactor*SolarInflux*0.12;
SolarMass = SolarMassUnit*RoverPower/SolarEfficiency;
SolarMassUnit = 6.5;   (* kg/m^2... this is due to the 3 surfaces of sol
BatteryMassUnit = 100;  (* Wh/kg *)
SolarArraySize = SolarMass/SolarMassUnit;
BatteryMass = NightSurvivalPower*NightDuration/BatteryMassUnit;
Emmissivity = 0.03;
NightSurvivalTemperature = 263;
NightSurvivalPower = NightPowerLoss*1; (* NO Safety margin here *)
```

■ RTG Power System Definition

```
AmtecEfficiency = 0.15;
AmtecMassUnit = 40;  (* W/kg *)
GPHSMass = 1.5; (* kg *)
GPHSEnergy = 250; (* Watts *)
GPHSStructural = 1.3;
RTGPower = RoverPower/(AmtecEfficiency);
RTGIsotopeMass = RTGPower/GPHSEnergy * (GPHSMass*GPHSStructural);
AmtecMass = RoverPower/AmtecMassUnit;
NightSurvivalTemperature = 203;
Emmissivity = 0.10;
NightSurvivalPower = NightPowerLoss*2; (* Safety margin here *)
RHUIsotopeMass = 0;
RHUConditionerMass = 0;
DeploymentMass = 0;
SolarMass = 0;
BatteryMass = 0;
RHUPower = 0;
```

■ Solar Power System Definitions

□ 100Batt, 0.02Emmis, 1x NightPower Solar Power System I (Toughest/Most Workable)

```
DeploymentMass = 5;
SolarEfficiency = CosineFactor*SolarInflux*0.12;
SolarMass = SolarMassUnit*RoverPower/SolarEfficiency;
SolarMassUnit = 6.5;   (* kg/m^2... this is due to the 3 surfaces of sol
BatteryMassUnit = 100;  (* Wh/kg *)
SolarArraySize = SolarMass/SolarMassUnit;
BatteryMass = NightSurvivalPower*NightDuration/BatteryMassUnit;
Emmissivity = 0.03;
NightSurvivalTemperature = 263;
NightSurvivalPower = NightPowerLoss*1; (* NO Safety margin here *)
RHUConditionerMass = 0;
RHUIsotopeMass = 0;
AmtecMass = 0;
GPHSMass = 0;
RTGIsotopeMass = 0;
HotRadiatorMass = 0;
RTGPower = 0;
RHUPower = 0;
```

☐ 40Batt, 0.03 Emmis, 1xNightPower Solar Power System II

```
DeploymentMass = 5;
SolarEfficiency = CosineFactor*SolarInflux*0.12;
SolarMass = SolarMassUnit*RoverPower/SolarEfficiency;
SolarMassUnit = 6.5;   (* kg/m^2... this is due to the 3 surfaces of sol
BatteryMassUnit = 40;  (* Wh/kg *)
SolarArraySize = SolarMass/SolarMassUnit;
BatteryMass = NightSurvivalPower*NightDuration/BatteryMassUnit;
Emmissivity = 0.03;
NightSurvivalTemperature = 263;
NightSurvivalPower = NightPowerLoss*1; (* NO Safety margin here *)
RHUConditionerMass = 0;
RHUIsotopeMass = 0;
AmtecMass = 0;
GPHSMass = 0;
RTGIsotopeMass = 0;
HotRadiatorMass = 0;
RTGPower = 0;
RHUPower = 0;
```

☐ 100 Batt, 0.10 Emmiss, 1x NightPower Solar Power System III

```
DeploymentMass = 5;
SolarEfficiency = CosineFactor*SolarInflux*0.12;
SolarMass = SolarMassUnit*RoverPower/SolarEfficiency;
SolarMassUnit = 6.5;   (* kg/m^2... this is due to the 3 surfaces of sol
BatteryMassUnit = 100;  (* Wh/kg *)
SolarArraySize = SolarMass/SolarMassUnit;
BatteryMass = NightSurvivalPower*NightDuration/BatteryMassUnit;
Emmissivity = 0.10;
NightSurvivalTemperature = 263;
NightSurvivalPower = NightPowerLoss*1; (* NO Safety margin here *)
RHUConditionerMass = 0;
RHUIsotopeMass = 0;
AmtecMass = 0;
GPHSMass = 0;
RTGIsotopeMass = 0;
HotRadiatorMass = 0;
RTGPower = 0;
RHUPower = 0;
```

☐ **100 Batt, 0.03 Emmiss, 2x NightPower Solar Power System IV**

```
DeploymentMass = 5;
SolarEfficiency = CosineFactor*SolarInflux*0.12;
SolarMass = SolarMassUnit*RoverPower/SolarEfficiency;
SolarMassUnit = 6.5;   (* kg/m^2... this is due to the 3 surfaces of sol
BatteryMassUnit = 100;  (* Wh/kg *)
SolarArraySize = SolarMass/SolarMassUnit;
BatteryMass = NightSurvivalPower*NightDuration/BatteryMassUnit;
Emmissivity = 0.03;
NightSurvivalTemperature = 263;
NightSurvivalPower = NightPowerLoss*2; (* NO Safety margin here *)
RHUConditionerMass = 0;
RHUIsotopeMass = 0;
AmtecMass = 0;
GPHSMass = 0;
RTGIsotopeMass = 0;
HotRadiatorMass = 0;
RTGPower = 0;
RHUPower = 0;
```

☐ **40 Batt, 0.1 Emmiss, 2x NightPower Solar Power System V**

```
DeploymentMass = 5;
SolarEfficiency = CosineFactor*SolarInflux*0.12;
SolarMass = SolarMassUnit*RoverPower/SolarEfficiency;
SolarMassUnit = 6.5;   (* kg/m^2... this is due to the 3 surfaces of sol
BatteryMassUnit = 40;  (* Wh/kg *)
SolarArraySize = SolarMass/SolarMassUnit;
BatteryMass = NightSurvivalPower*NightDuration/BatteryMassUnit;
Emmissivity = 0.1;
NightSurvivalTemperature = 263;
NightSurvivalPower = NightPowerLoss*2; (* NO Safety margin here *)
RHUConditionerMass = 0;
RHUIsotopeMass = 0;
AmtecMass = 0;
GPHSMass = 0;
RTGIsotopeMass = 0;
HotRadiatorMass = 0;
RTGPower = 0;
RHUPower = 0;
```

■ RHU Power System Definition ->Also requires a solar system

□ RHU without batteries, actuated RHU box, 0.10 Emmiss, 2x NightPower I

```
RHUMass = 0.2;  (* kg *)
RHUEnergy = 8.5;
RHUStructural = 1.15;
RHUIsotopeMass = RHUNumber * (RHUMass*RHUStructural);
RHUConditionerMass = 10;
RHUPower = 0;
BatteryMass = 0;
NightSurvivalTemperature = 203;
Emmissivity = 0.10;
NightSurvivalPower = NightPowerLoss*2; (* Safety margin here *)
RHUNumber = NightSurvivalPower/RHUEnergy;
```

□ RHU with 10kg batteries, actuated RHU box, 0.10 Emmiss, 2x NightPower II

```
RHUMass = 0.2;  (* kg *)
RHUEnergy = 8.5;
RHUStructural = 1.15;
RHUIsotopeMass = RHUNumber * (RHUMass*RHUStructural);
RHUConditionerMass = 10;
RHUPower = 0;
BatteryMass = 10;
NightSurvivalTemperature = 263;
Emmissivity = 0.10;
NightSurvivalPower = NightPowerLoss*2; (* Safety margin here *)
RHUNumber = NightSurvivalPower/RHUEnergy;
```

□ RHU with batteries, UNactuated RHU box, 0.10 Emmiss, 2x NightPower III

```
RHUMass = 0.2;  (* kg *)
RHUEnergy = 8.5;
RHUStructural = 1.15;
RHUIsotopeMass = RHUNumber * (RHUMass*RHUStructural);
RHUConditionerMass = 0;
BatteryMass = 10;
NightSurvivalTemperature = 263;
Emmissivity = 0.10;
NightSurvivalPower = NightPowerLoss*2; (* Safety margin here *)
RHUNumber = NightSurvivalPower/RHUEnergy;
RHUPower = NightSurvivalPower;
```

Glorious Results

Mass/Power Equation Solutions

```
Clear[RoverMass,RoverPower];
MassEqn := RoverMass == LocomotionMass + PayloadMass + ThermalMass + Pow
PowerEqn := RoverPower == ((PayloadPower/PayloadInefficiency)+Locomotion
                            (PowerInefficiency)
Tmp = RoverMass/.Solve[{MassEqn,PowerEqn},{RoverMass,RoverPower}][[1]]//
RoverPower = RoverPower/.Solve[{MassEqn,PowerEqn},{RoverPower,RoverMass}
RoverMass = Tmp;
```

System interesting results

```
{"SYSTEM: PayloadMass:",PayloadMass, "PayloadPower:",PayloadPower, "Radi
```

```
{SYSTEM: PayloadMass:, 69, PayloadPower:, 277., RadiatorSize:,
  1.45643}
```

NON Payload rover

```
{"NON Payload: Power:",RoverPower, "Mass:",RoverMass, "LocoMass:",Locomo
 "InsulationMass:",InsulationMass//N, "SolarArraySize:",SolarArraySize//
```

```
{NON Payload: Power:, 149.793, Mass:, 456.191, LocoMass:,
  159.667, BatteryMass:, 175.785, InsulationMass:, 99.3419,
  SolarArraySize:, 1.0614, NightSurvivalPower:, 48.8291}
```

```
InsulationMass//N
```

```
16.7061
```

RTG interesting results

```
{"RTG POWER: Power:",RoverPower, "Mass:",RoverMass, "HotRadiatorSize:",H
```

```
{RTG POWER: Power:, 420.444, Mass:, 205.19, HotRadiatorSize:,
  0.53334, RTG Power:, 2802.96}
```

☐ Solar I interesting results (basic)

```
{"SOLAR I: Power:",RoverPower, "Mass:",RoverMass, "BatteryMass:",Battery
 "SolarArraySize:",SolarArraySize//N, "NightSurvivalPower:",NightSurviva
```

```
{SOLAR I: Power:, 570.496, Mass:, 666.1, BatteryMass:, 175.785,
  InsulationMass:, 143.03, SolarArraySize:, 4.04242,
  NightSurvivalPower:, 48.8291}
```

☐ Solar II interesting results (realistic batteries)

```
{"SOLAR II: Power:",RoverPower, "Mass:",RoverMass, "BatteryMass:",Batter
 "SolarArraySize:",SolarArraySize//N, "NightSurvivalPower:",NightSurviva
```

```
{SOLAR II: Power:, 775.693, Mass:, 1296.4, BatteryMass:,
  439.462, InsulationMass:, 279.594, SolarArraySize:, 5.4964,
  NightSurvivalPower:, 48.8291}
```

☐ Solar III interesting results (realistic emmissivity)

```
{"SOLAR III: Power:",RoverPower, "Mass:",RoverMass, "BatteryMass:",Batte
 "SolarArraySize:",SolarArraySize//N, "NightSurvivalPower:",NightSurviva
```

```
{SOLAR III: Power:, 761.67, Mass:, 1253.32, BatteryMass:,
  585.949, InsulationMass:, 105.754, SolarArraySize:, 5.39703,
  NightSurvivalPower:, 162.764}
```

☐ Solar IV interesting results (realistic nightpower margin)

```
{"SOLAR IV: Power:",RoverPower, "Mass:",RoverMass, "BatteryMass:",Batter
 "SolarArraySize:",SolarArraySize//N, "NightSurvivalPower:",NightSurviva
```

```
{SOLAR IV: Power:, 707.294, Mass:, 1086.3, BatteryMass:,
  351.569, InsulationMass:, 234.073, SolarArraySize:, 5.01174,
  NightSurvivalPower:, 97.6582}
```

☐ Solar V interesting results (completely realistic rover)

```
{"SOLAR IV: Power:",RoverPower, "Mass:",RoverMass, "BatteryMass:",Batter
 "SolarArraySize:",SolarArraySize//N, "NightSurvivalPower:",NightSurviva
```

```
{SOLAR IV: Power:, 2148.45, Mass:, 5513.04, BatteryMass:,
  2929.74, InsulationMass:, 466.905, SolarArraySize:, 15.2235,
  NightSurvivalPower:, 325.527}
```

□ RHU I interesting results

```
{"RHU POWER: Power:",RoverPower, "Mass:",RoverMass, "RHUNumber:",RHUNumb
 "SolarArraySize:",SolarArraySize//N, "NightSurvivalPower:",NightSurviva
```

```
{RHU POWER: Power:, 422.742, Mass:, 212.248, RHUNumber:,
  13.5934, InsulationMass:, 17.4895, SolarArraySize:, 2.99546,
  NightSurvivalPower:, 115.544}
```

□ RHU II interesting results

```
{"RHU POWER: Power:",RoverPower, "Mass:",RoverMass, "RHUNumber:",
  RHUNumber, "InsulationMass:",InsulationMass//N,"SolarArraySize:",
  SolarArraySize//N,"NightSurvivalPower:",NightSurvivalPower}
```

```
{RHU POWER: Power:, 432.021, Mass:, 240.749, RHUNumber:,
  38.2973, InsulationMass:, 19.9059, SolarArraySize:, 3.06121,
  NightSurvivalPower:, 325.527}
```

□ RHU III interesting results

```
{"RHU POWER: Power:",RoverPower, "Mass:",RoverMass, "RHUNumber:",
  RHUNumber, "InsulationMass:",InsulationMass//N,
 "RadiatorSize:",RadiatorSize,"SolarArraySize:",
  SolarArraySize//N, "NightSurvivalPower:",NightSurvivalPower}
```

```
{RHU POWER: Power:, 428.914, Mass:, 231.206, RHUNumber:,
  38.2973, InsulationMass:, 18.3845, RadiatorSize:, 3.50989,
  SolarArraySize:, 3.0392, NightSurvivalPower:, 325.527}
```

□ SavedResults

```
{SYSTEM: PayloadMass:, 69, PayloadPower:, 277, RadiatorSize:, 1.50779}
```

```
{NON Payload: Power:, 151.712, Mass:, 462.088, LocoMass:, 161.731, Batte
  InsulationMass:, 100.088, SolarArraySize:, 1.29094, NightSurvivalPower
```

```
{RTG POWER: Power:, 420.52, Mass:, 205.422, HotRadiatorSize:, 0.53619, R
```

```
{SOLAR I: Power:, 654.283, Mass:, 923.465, BatteryMass:, 277.306, Insula
  SolarArraySize:, 5.56736, NightSurvivalPower:, 48.8291}
```

```
{SOLAR II: Power:, 781.389, Mass:, 1313.89, BatteryMass:, 439.462, Insul
  SolarArraySize:, 6.64893, NightSurvivalPower:, 48.8291}
```

```
{SOLAR III: Power:, 649.732, Mass:, 909.485, BatteryMass:, 390.633, Insu
  SolarArraySize:, 5.52864, NightSurvivalPower:, 162.764}

{SOLAR IV: Power:, 620.635, Mass:, 820.109, BatteryMass:, 234.38, Insula
  SolarArraySize:, 5.28105, NightSurvivalPower:, 97.6582}

{RHU POWER: Power:, 425.139, Mass:, 219.612, RHUNumber:, 13.5934, Insula
  SolarArraySize:, 3.61756, NightSurvivalPower:, 115.544}
```