2.4 Predict the Transfer Orbit Parameters (Continued)

$$\frac{2r_{at}}{r} = \left(\frac{r_{at}}{r_{pt}} + 1\right) + \left(\frac{r_{at}}{r_{pt}} - 1\right) \cos \theta_t$$

Similarly,

$$\frac{2r_{af}\, r_{pf}}{r_{af}+r_{pf}} = r \left[1 + \frac{r_{af}-r_{pf}}{r_{af}+r_{pf}} \cos \theta_f\right]$$

$$\frac{2r_{af}}{r} = \left(\frac{r_{af}}{r_{pf}} + 1\right) + \left(\frac{r_{af}}{r_{pf}} - 1\right) \cos \theta_f$$

The solutions for the apogee radius of the transfer orbit and the radius of intersection are simplified if a transfer orbit is selected such that injection into the final orbit occurs at the point of tangency of the two orbits. At tangency, the flight path angles (γ) must be equal.

For any orbit,

$$\cos \gamma = \sqrt{\frac{r_a\, r_p}{r(r_a+r_p-r)}}$$

At tangency,

$$\frac{r_{af}\, r_{pf}}{r_{af} + r_{pf} - r_{tan}} = \frac{r_{at}\, r_{pt}}{r_{at} + r_{pt} - r_{tan}}$$

$$r_{tan} = \frac{r_{af}\left(\frac{r_{at}}{r_{pt}} + 1\right) - r_{at}\left(\frac{r_{af}}{r_{pf}} + 1\right)}{\frac{r_{af}}{r_{pt}} - \frac{r_{at}}{r_{pf}}}$$