2.6 Establish Time the Launch Site Crosses the Orbital Plane (Continued)

$$\Omega_e t_L = A_L - \Lambda_L = (A_L - \Omega) + (\Omega - \Lambda_L)$$

$$t_L = \frac{1}{\Omega_e}\left[\Omega - \Lambda_L + \sin^{-1}\left(\frac{\tan L_L}{\tan_i}\right) \right] \text{ for northerly launches}$$

For southward launches

$$\Omega_e t_L = \Omega - \Lambda_L + 180° - (A_L - \Omega)$$

and

$$t_L = \frac{1}{\Omega_e}\left[\Omega - \Lambda_L - \sin^{-1}\left(\frac{\tan L_L}{\tan_i}\right) + 180° \right]$$

The perturbing influence of the earth's oblateness may be added to this geometric formulation. Secular regression rates in the various orbits are given by:

$$\dot{\Omega} = \frac{-3\pi J_2 \cos i}{\left(\frac{a}{R}\right)^2 (1-e^2)^2} \frac{\text{rad}}{\text{orbit}}$$

$$= \frac{-540° J_2 \cos i}{\left(\frac{a}{R}\right)^2 (1-e^2)^2} \frac{\text{deg}}{\text{orbit}} \; ; \; 0° < i < 180° \qquad (2\text{-}6\text{-}2)$$