When the transmit power of each base station is equal and the path loss exponent is the same throughout the coverage area, S/I for a mobile can be approximated as

$$\frac{S}{I} = \frac{R^{-n}}{\sum_{i=1}^{i_0} (D_i)^{-n}} \tag{3.8}$$

Considering only the first layer of interfering cells, if all the interfering base stations are equidistant from the desired base station and if this distance is equal to the distance D between cell centers, then Equation (3.8) simplifies to

$$\frac{S}{I} = \frac{(D/R)^n}{i_0} = \frac{(\sqrt{3N})^n}{i_0} \tag{3.9}$$

Equation (3.9) relates S/I to the cluster size N, which in turn determines the overall capacity of the system from Equation (3.2). For example, assume that the six closest cells are close enough to create significant interference and that they are all approximately equidistant from the desired base station. For the U.S. AMPS cellular system which uses FM and 30 kHz channels, subjective tests indicate that sufficient voice quality is provided when S/I is greater than or equal to 18 dB. Using Equation (3.9), it can be shown in order to meet this requirement, the cluster size N should be at least 6.49, assuming a path loss exponent $n = 4$. Thus a minimum cluster size of seven is required to meet an S/I requirement of 18 dB. It should be noted that Equation (3.9) is based on the hexagonal cell geometry where all the interfering cells are equidistant from the base station receiver, and hence provides an optimistic result in many cases. For some frequency reuse plans (e.g., $N = 4$), the closest interfering cells vary widely in their distances from the desired cell.

Using an exact cell geometry layout, it can be shown for a seven-cell cluster, with the mobile unit at the cell boundary, the mobile is approximately $D - R$ from the two nearest co-channel interfering cells and approximately $D + R/2$, D, $D - R/2$, and $D + R$ from the other interfering cells in the first tier, as shown rigorously in [Lee86]. Using the approximate geometry shown in Figure 3.5, Equation (3.8), and assuming $n = 4$, the signal-to-interference ratio for the worst case can be closely approximated as (an exact expression is worked out by Jacobsmeyer [Jac94])

$$\frac{S}{I} = \frac{R^{-4}}{2(D-R)^{-4} + 2(D+R)^{-4} + 2D^{-4}} \tag{3.10}$$

Equation (3.10) can be rewritten in terms of the co-channel reuse ratio Q, as

$$\frac{S}{I} = \frac{1}{2(Q-1)^{-4} + 2(Q+1)^{-4} + 2Q^{-4}} \tag{3.11}$$