Cycle Service Level and Fill Rate

The safety stock equations may actually give you more protection than you expect, or they may provide less – it all depends on how you measure customer service. These equations will predict the safety stock needed so that a certain percentage, say 95%, of the replenishment cycles will be completed without a stockout. This is often called Cycle Service Level. However, business leaders often want to control the percentage of total volume ordered that is available to satisfy customer demand, not the percentage of cycles without a stockout. This quantity is called fill rate, and is often considered to be a better measure of inventory performance. Figure 5 illustrates the difference. Where cycle service level is an indication of the frequency of stockouts, without regard to the total magnitude, fill rate is a measure of inventory performance on a volumetric basis.

![Figure 5 Cycle Service Level & Fill Rate](image)

The specific calculations of safety stock required to achieve a desired fill rate are beyond the scope of this article. An excellent discussion can be found in Chopra & Meindl (3). However, some observations are in order. With very stable demand patterns and supply behavior, i.e. low standard deviations of demand and lead time, fill rate will generally be higher than cycle service level, as illustrated in figure 6. Although stockouts will occur, with low supply and demand variability the magnitude of each stockout will be very small. On the other hand, with very high variability in either demand or lead time or both, the opposite will usually be found. Figure 7 illustrates a case where demand variability is high, where the standard deviation of demand is half of the average demand. Although there are few stockouts (because
of the safety stock being carried) the magnitude of any stockout can be quite high. Thus in this case the fill rate is actually less than the CSL.

Stockouts will occur, but with low demand variability, material shorted will be very low
So Fill Rate will exceed CSL

Figure 6  Inventory Profile with Low Demand Variability (CV = 0.2)

With high demand variability, there may be few stockouts, but the amount can be quite large!
So Fill Rate can be lower than CSL

Figure 7  Inventory Profile with High Demand Variability (CV = 0.5)

Peter L. King
January, 2011