Spare Parts Requirements Forecasting (Continued)

Improved Reliability With Preventive Maintenance

One can treat the successive maintenance time intervals as a series situation. Each replacement returns the system to "good as new" and can be modeled after k periods of time as:

$$R(kt_p + t) = [R(t_p)]^k\,[R(t)]$$

so at time t, beyond the last or k th replacement, yields:

$$MTBF_{pm} = \int_0^{\infty} R(kt_p + t)dt = \int_0^{t}\sum_0^{\infty}[R(t_p)]^k R(t)dt = \sum_0^{\infty}[R(t_p)]^k \int_0^{t} R(t)dt$$

$$\text{Where: } \sum_0^{\infty}[R(t_p)]^k = \frac{1}{1 - R(t_p)}$$

Example 8.21: Let a two pump parallel system have a mean life of 100 hours. If PM is performed each 90 hours, how much is the MTTF improved?

For two parallel pumps, needing one to operate, the reliability is

$$R = 1 - [1\text{-}R(t)]^2 = 2R - R^2$$

$$\text{The normal MTTF} = \int_0^{\infty}(2R - R^2)dt = \int_0^{\infty}(2e^{-\lambda t} - e^{-2\lambda t})dt = \frac{3}{2\lambda} = 150 \text{ hours}$$

With preventive maintenance, MTTF becomes:

$$MTTF_{pm} = \frac{\int_0^{\infty}(2R - R^2)dt}{1 - R_{sys}} = \frac{\frac{3}{2\lambda_{pm}}}{1 - 2R(t_p) + [R(t_p)]^2} = \frac{135.14}{0.3995} = 338.3 \text{ hours}$$

Thus, a MTTF improvement factor of 338.3/150 = 2.26 is achieved when PM is performed.