APPENDIX K - TEST SAMPLE PLANNING

Test Sample Strategies

The following are typical of commercial practices in test sample planning for given situations. Here are sample size determinations for the following situations:

(A) Demonstration test setup if customer R/C life goals are provided.

$R_C = (1.0 - C)^{1/N} \Rightarrow N = \frac{Ln(1.0 - C)}{Ln(R)}$. Example: Given R=. 99; C=. 90 at T=150,000 miles, what is "N" required without failure to demonstrate that goals have been met?

$N = \frac{Ln(.10)}{Ln(.99)} = 229.10 \cong 229$. Test 229 units each to 150,000 miles without failure to demonstrate goals have been met.

(B) Failure mode resolution "verification" or Demonstration test setup if customer R/C life goals are providedand stress/acceleration (S) factor is known for a given mode of failure concern we are testing for.

$R_C = (1.0 - C)^{1/(N*S)} \Rightarrow N = \left(\frac{1}{S}\right) * \left(\frac{Ln(1.0 - C)}{Ln(R)}\right)$. Example: Given R=. 99; C=. 90, S=5.26/1 at T=150,000 miles, what is "N" required without failure to demonstrate that goals have been met?

$N = \left(\frac{1}{5.26}\right) * \left(\frac{Ln(1.0)}{Ln(.99)}\right) = 43.56 \cong 44.$ Test 44 units each to 150,000 miles without failure to demonstrate goals have been met.

(C) Failure mode resolution "verification" or Demonstration test setup if customer R/C life goals are provided, stress/acceleration (S) factor is known, and historical Weibull slope is known for a given mode of failure concern we are testing for.

$R_C = (1.0 - C)^{1/(N*S^b)} \Rightarrow N = \left(\frac{1}{S^b}\right) * \left(\frac{Ln(1.0 - C)}{Ln(R)}\right)$. Example: Given R=. 99; C=. 90, S=5.26/1, and Weibull slope = 2.2 at T=150,000 miles, what is "N" required without failure to demonstrate that goals have been met?

$N = \left(\frac{1}{5.26^{2.2}}\right) * \left(\frac{Ln(1.0)}{Ln(.99)}\right) = 5.94 \cong 6.0.$ Test 6 units each to 150,000 miles without failure to demonstrate goals have been met.

(D) Failure mode resolution "verification" if customer R/C goals providedand the required Weibull life and slope are known.

$$N = \left(\frac{Ln\left[\frac{1}{1.0 - C}\right]}{\left(\frac{T}{\theta}\right)^{b}} \right)$$

Example:

Given R =. 95, C =. 90, Weibull slope = 2.2 at T = 120,000 miles. How many units do we need to test and for how long to demonstrate that the goals have been met? Suppose the test is to be terminated at 100,000 miles.

$$R = B_Q = B_{.05} = \theta * Ln(2)$$
$$\Rightarrow \theta = \frac{B_{.05}}{Ln(2)} = \frac{120{,}000 \text{ miles}}{.693147}$$
$$\Rightarrow \theta = 173{,}123.4 \text{ miles}.$$

Placing this value in the next equation and solving for N:

$$C = 1.0 - \exp\left[-N * \left(\frac{T}{\theta}\right)^{b}\right] \Rightarrow 1.0 - C = \exp\left[-N * \left(\frac{T}{\theta}\right)^{b}\right] \Rightarrow$$

$$Ln\left(\frac{1}{1.0 - C}\right) = N * \left(\frac{T}{\theta}\right)^{b} \Rightarrow N = \left(\frac{Ln\left(\frac{1}{1.0 - C}\right)}{\left(\frac{T}{\theta}\right)^{b}} \right)$$

with C=. 90, T=100,000 miles, b= 2.2 and theta = 173,123.4 miles we net

$$N = \left(\frac{Ln(10)}{\left(\frac{100{,}000}{173{,}123.4}\right)^{2.2}} \right) = \left(\frac{2.302585}{(.57762266)^{2.2}} \right) \Rightarrow N = \left(\frac{2.302585}{0.2989629} \right) = 7.7 \cong 8$$

Test eight (8) units 100,000 miles each to demonstrate that the goals have been met.

References

Lipson and Sheth. *Statistical Design and Analysis of Engineering Experiments, .* McGraw-Hill, 1973, Chapter 5.