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Reliability & Variation Research

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STEPS TO RELIABILITY

INTRODUCTION

Planning to succeed is of utmost importance in an effective reliability program. It is, as a matter of fact, an example of the power of the scientific approach to industrial problems which involve probabilities and certain inherent variations. Each historical example of successful procedures has, as a rule, involved definite steps toward a given goal or objective. The same is true in the field of product reliability. there are definite steps to reliability which will definitely help to reach a desired level of product reliability in any industry whose success depends on public satisfaction with a product's service performance. This is true for anything from automobiles to stapling machines.

The purpose of this bulletin is to outline four basic steps to reliability in an industrial product development program in which success is closely related to reliability of usage by the purchasing public.

STEP # 1

ESTABLISH A DESIRABLE RELIABILITY GOAL LINE WITH PARAMETERS SPECIFIED.

What is a Desirable Goal ?

A desirable level of reliability is one which produces a profit from good (reliable) items which is sufficiently larger* than the losses from bad (unreliable) items .

* It is the producer's choice as to how large he wants the prfitability factor to be . We define it as follows :

$$\text{PROFITABILITY FACTOR} = \frac{\text{GAINS FROM GOOD ITEMS}}{\text{LOSSES FROM BAD ITEMS}}$$

$$= \frac{G\,R}{L(1 - R)} = K_{GOAL}$$

G = Dollar gain per good item

L = Dollar loss per bad item

R = Reliability goal

STEP # 2

Test a small sample of items (with at least 3 failures) and construct an Entropy Growth Curve on log-log paper.

(a) At any warranty target (say 12,000 miles) calculate the confidence that the Entropy on the Growth Curve is less than the Entropy on the Goal line at the same warranty target. This will be the confidence that the profitability factor chosen in Step # 1 will be realized.

(b) Furthermore, the profitability factor with 50% confidence will be given by the ratio

$$\frac{G\,R_{Test}}{L(1 - R_{Test})}$$

where

G = Dollar gain per good item

L = Dollar loss per bad item

R_{Test} = Reliability to Warranty target on the test data plot.

FORMULA: $R_{Test} = e^{-\text{Entropy at Target on Test Growth Curve}}$

STEP # 3

In order to be sure that the profitability factor never turns out less than half the producer's choice of profit - ability factor check to see if the upper 3 sigma limit on the logarithm of the test Entropy at warranty target yields at least half the producer's choice of profitability factor. If the test data plot fails this test then the sample size is too small, and more tests are needed.

CRITERION FOR GOOD TEST RESULTS

At Warranty Target (say 12,000 miles) :

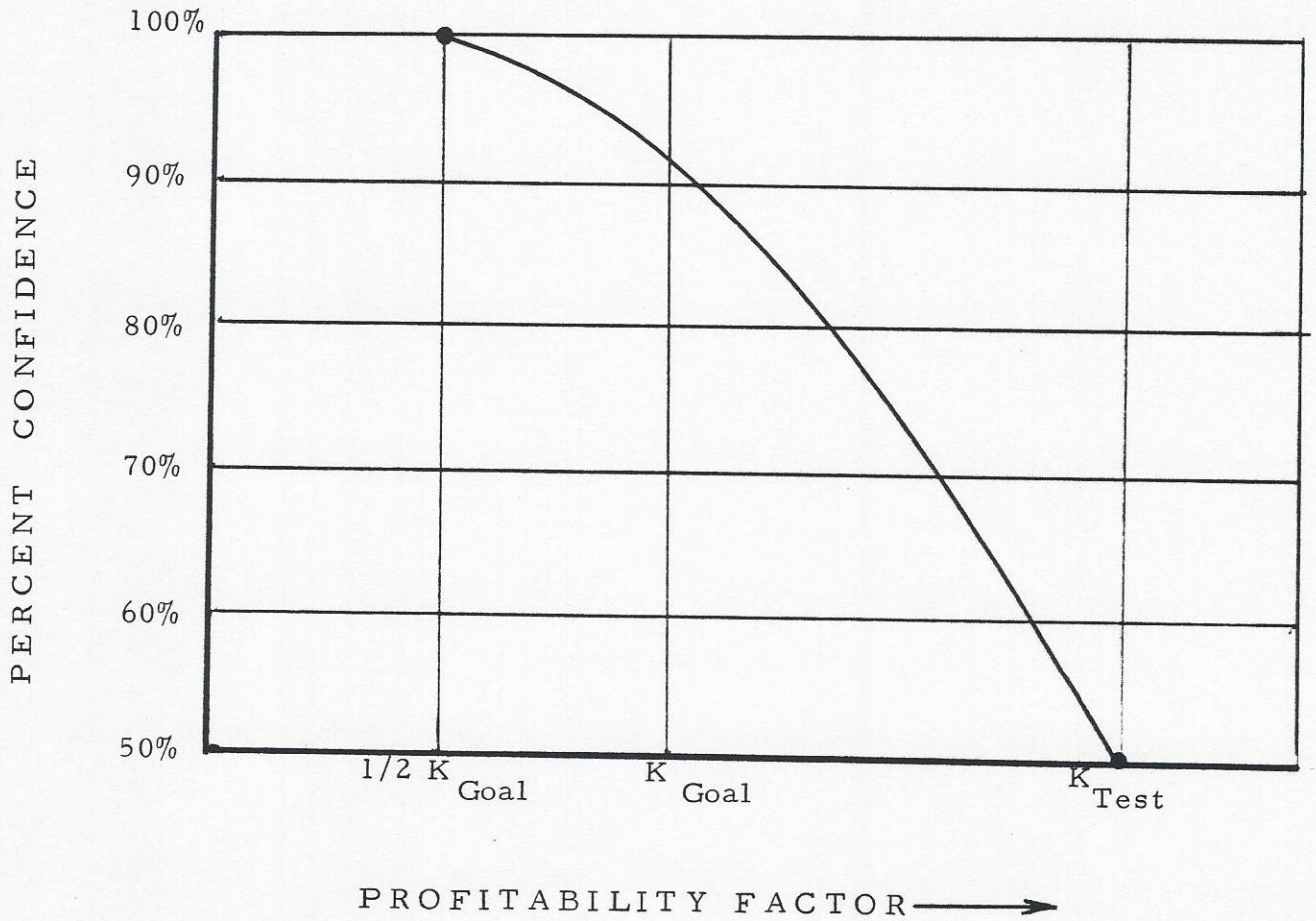
$$\text{TEST ENTROPY} < e^{-3/\sqrt{N}} \ln\left(\frac{2}{R_{Goal}} - 1\right)$$

where N = sample size at the Warranty target

R_{Goal} = Goal line Reliability at Warranty target

Upon completing all test analysis in the first three steps, construct a Confidence Interpolation Diagram for the Profitability Factor.

STEP # 4



G = Dollar gain per good item ; L = Dollar loss per bad item

$$K_{Goal} = \frac{G R_{Goal}}{L(1 - R_{Goal})} \quad ; \quad K_{Test} = \frac{GR_{Test}}{L(1 - R_{Test})}$$

R_{Goal} = Goal Line Reliability (at warranty target) ; R_{Test} = Test Reliability (at warranty target)

NOTE: In order to be sure of at least breaking even make $K_{Goal} \geq 2$.